COTTON SPINNING MACHINERY

AND ITS USES

CHAPTER I

TEXTILE FIBRES

A FIBRE may be described as a thread-like growth or constituent of a substance or a substance drawn out to a thin condition. A vast number of sources exist from which fibres may be obtained. Plants supply us with jute, hemp, linen, cotton, ramie, etc. Animals give us wool, hair, bristles, silk, gut, etc., whilst from minerals we obtain asbestos, glass, and metallic wires of various kinds. In addition to these we have a series of fibres produced chemically and mechanically, such as artificial silks, which may be either of animal or vegetable origin. All these types of fibres are used commercially for textile purposes. Our attention in the following pages will be confined to the cotton fibre, which, as noted above, is of vegetable origin.

The Cotton Plant. The cotton fibre is the seed hair of a plant of the natural order of *Malvacea.* The genus of the order to which the cotton producing plant belongs is *Gossypium*, and all the cotton used in our mills is one or the other of the species of this genus. There is a considerable

difference of opinion among botanists as to the number of species. A description of fifty-two varieties has been made by an Italian writer, and the Kew Index contains a list of forty-two distinct species. For our present purpose only four species need be considered, viz., Gossypium Arboreum; Gossypium Herbaceum; Gossypium Barbadense; Gossypium Hirsutum.

Gossypium Arboreum, as its name implies, is a tree-like plant ranging from 12 ft. to 18 ft. high. It is perennial, and lasts for five to six years. The flowers are purple and the fibres are fine, silky, and a good length. This tree cotton is not grown commercially, though its cultivation is probably more ancient than that of any other kind of cotton plant.

Gossypium Herbaceum includes most of the cotton from India, China, and Southern Asia, and the short stapled Egyptian cottons. The plant is an annual, growing from 5 ft. to 6 ft. high. The seeds have an undergrowth of soft down.

Gossypium Barbadense comprises the long silky fibres of the Sea Island, Egyptian and Peruvian cottons. Its height is from 6 ft. to 8 ft. when grown as a perennial, but only 3 ft. to 4 ft. high when cultivated as an annual or biennial. The seeds are small, black, and not covered with an undergrowth of short fibres, so they come clean from the gin.

Gossypium Hirsutum includes most of the cotton grown in the Southern United States, and is commonly known as Upland or Peeler cotton. It is grown as an annual, and grows from 2 ft. to 7 ft. high. The seeds are covered with an undergrowth of down.

Sources of the Supply of Cotton. The bulk of our raw cotton comes from the United States of America, Egypt, and India. Other parts of the world grow cotton, but to a less extent than the three just named, such as Peru, Brazil, West Indies, Mexico, Asia, China, East and West Africa, etc. As the cotton plant is a native of subtropical regions and requires a warm and humid atmosphere it can be cultivated economically within a fairly large belt of the world where these conditions exist, and a sandy type of soil is present. This belt may be fixed at about 40° on either side of the Equator, though it is much better to use the isothermal line of 60° F. as the limit of its growth for commercial purposes. As the present supply of cotton is not equal to the demand, various agencies are at work trying to develop cotton growing in parts of the world that are suitable for it. The British Cotton Growing Association is one of the most successful of these agencies, and large tracts of land in East and West Africa are now sending us supplies.

Names of Cotton. Whilst the cotton plant is split up into families, all of which have their special characteristics, these botanical distinctions are practically a dead language to the commercial and technical man, and a variety of other names and terms are used to distinguish the cottons from various parts of the world. The general names used officially are—

American; Brazilian; Egyptian; Peruvian; West Indian; African; East Indian; and Sea Islands.

Each of these general names is split up into a number of local designations, many of which are

used only among the growers of the cottons. Some of these names are given here to indicate this phase.

AMERICAN COTTONS. Uplands; Boweds; Texas; Orleans; Mobile, etc. These are still further divided into a multitude of names of a local character such as Boyd Prolific; Allen; Dickson; Herlong; Peeler; Texas Storm Proof; etc.

EGYPTIAN COTTONS. Mitafifi; Assili; Abassi; Ashmouni; Sakellarides; Voltos; Tokar; Soudan; etc. Quotations in the official list in Liverpool include all Egyptian cottons under Upper; Sakel, and Brown.

INDIAN COTTONS. East Indian cotton is understood by this term. They include Tinnevelly; Westerns; Northerns; Cocanadas; Broach; Kumpta; Surtee; Oomra; Bengal; Scinde; Khandeish; etc. A common general name for Indian cottons is Surat.

PERUVIAN COTTONS. These are generally known as Rough and Smooth Peruvian cottons. A Peruvian Sea Island cotton is also grown.

BRAZILIAN COTTONS. Maranham; Pernam; Parahyba; Maceio; Ceara.

AFRICAN COTTONS. These include cottons grown in Africa outside the Egyptian districts. No specific names have as yet become attached to the various types. At present they are known as East and West African cottons.

Grades of Cotton. Cotton from each of the districts named above is not of uniform character. The bulk of the cotton, therefore, bought by our mills is purchased on the basis of the grade of the cotton. The Liverpool Cotton Association has ten grades for American cotton; six grades for Egyptian; six for Indian; and three for Brazilian cotton. There is a wide difference in value between the lowest and highest grade of each type of cotton. Appearance is the main factor

in grading the cottons, so that cleanliness, colour, lustre, etc., are the essential features.

Cultivation of Cotton Plants. This phase of the subject is of little practical value to the mill worker. Probably at some stage in his career he will learn, from various sources, when to expect the new crop of the various cottons and even be interested in the daily reports as to its progress in growth under the influence of variations in climatic conditions, insect pests, etc. At the moment it is sufficient to point out that, as the bulk of the cotton used in our mills is grown as an annual plant, it is sown in the open fields in prepared ground, in much the same way as other crops are sown. When the young plants come up they are thinned out, and ultimately long rows of strong plants are seen spaced apart at suitable distances to permit adequate room for full development. The ground is kept well hoed and free from weeds. In due time the plant flowers, and as the flowers die off a small seed pod is left which continues to grow until the seeds within the pod attain maturity and burst the seed pod or capsule. A sketch of this seed pod is shown in Fig. 1, whilst in Fig. 2 we have a rough representation of the pod when it has burst and the mass of fibres has been exposed to the sun for a short time. It will be seen that the bursting of the seed pod is due to the growth of a mass of fibres which develop from the cuticle or skin of the seeds. Each pod contains a number of seeds, and under normal conditions the fibres would dry up, and the wind would blow the seeds apart and carry them away, much in the same way that hairy seeds are dispersed in our gardens and fields.

In strong healthy plants the seed pods will burst when the bulk of the fibres have attained their full growth, but this is an ideal condition never fulfilled in a cotton field. Many seed pods burst prematurely, whilst others are retarded, so

FIG. 1.—COTTON SEED POD

FIG. 2.—SEED POD BURST AND FIBRES EXPOSED

that, in spite of care in gathering the cotton, we find quantities of unripe and over-ripe fibres mixed with the mature fibres. As it is the nature of the cotton fibres to dry up quickly when the seed pod has burst, it is necessary to gather the exposed cotton at once, and this is done chiefly by labourers going around the plants and picking off the bunches of cotton that are exposed: "bolls of cotton" is the usual designation for cotton in this condition.

The Seed and its Fibres. If a piece be detached carefully from its fellows and examined it will be found that there is a hard centre, the seed,

surrounded by fibres in a curly and entangled condition. With a little care the fibres can be combed out as shown in Fig. 3. Much may be learned by an examination of the fibres in this their natural condition, and especially if various kinds of cotton are examined on the seeds. It will be found that there is no great uniformity in the length of the fibres, and also that the fibre itself is very short and scarcely suggests that it can be used commercially. Many seeds have a layer of short downy hairs on the surface of the seeds, whilst others have a very clean surface. Again we may find, in trying to detach the fibres, that on some seeds the fibres come away easily, whilst in other seeds they adhere tenaciously, and will break before yielding at the seed surface. The fibres, having no root as in human hair, but being part and parcel of the skin of the seed, must be broken off in order to free them from the seed, and this brings us to the first process through which cotton must pass before it can be utilized in our mills.

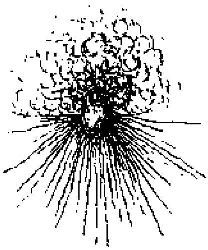

FIG. 3. COTTON SEED WITH FIBRES COMBED OUT

Ginning the Cotton. The operation of removing the fibres from the seeds is termed "ginning." In the very early days this removal of fibres was done by hand; later, small hand-worked machines called "Churkas" were used, and in some cases are still used. But manual labour can only turn

out a very small production, hence special machinery has been devised for doing the work quickly. Two types of gins are used, each having a distinct method of detaching the fibres.

In Fig. 4 it will be seen that if seed cotton is presented to the two revolving rollers *A* and *B*, the fibres will be carried forward, but as roller *A*

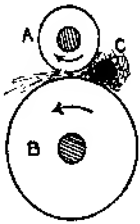

FIG. 4.—ILLUSTRATING PRINCIPLE OF "CHURKA" GIN.

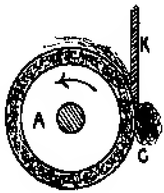

FIG. 5.—GIN ROLLER AND DOCTOR KNIFE.

presses hard on *B*, the seed cannot follow since the two rollers are small in diameter. The consequence is that the fibres are simply torn from the surface of the seed, which falls away in a stripped condition. This is the old churka principle of action, and it has been adopted for one of the types of gins. Instead of two rollers only one roller is used, the other being substituted by a steel plate or doctor-knife, *K*, as shown in Fig. 5. A large roller, covered by a thick layer of leather or even made entirely of leather, and running at a high speed, has a steel plate pressed strongly against it, the lower edge of this plate being fairly sharp. If we now place some seed cotton near the point where the steel plate *K* touches the roller *A*, the

fibres will be carried between the plate and roller, but the seed cannot follow, and as a result the fibres will be torn from the seed. In order to ensure that all sides of the seed are presented to the roller and doctor-knife, a mechanical tapping effect is introduced which, by rapidly repeated blows, knocks away the seeds and enables them

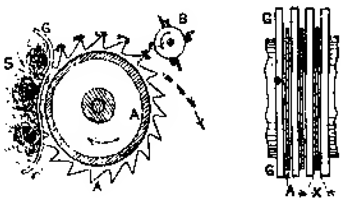

FIG. 6.—SAW-TYPE GINNING MACHINE.

to present other parts of their fibres to the action of the roller until they are entirely stripped and fall down through a grid.

The second type of gin acts in a manner quite different from that of the one first mentioned. A series of thin circular saws, at fixed distances apart, are threaded on a shaft. Between each pair of saws is fixed a bar so that the series of bars presents a surface through which the saw teeth project. Fig. 6 represents this principle of action. The saws *A* revolve at a high speed, and the seed cotton at *S*, pressing against the bars *G*, is caught by the saw teeth and dragged between the bars. The spaces between the bars are too narrow to allow the seed to pass through, so that the fibres are snapped off and carried forward. It will be noted that the effectiveness of the action

depends upon the curly and entangled condition of the seed fibres; straight fibres could not be detached by this gin. As a consequence of this method, the fibres are broken off at other parts of their length as well as at the surface of the seed, this depending upon the relative strengths at the various points of the fibres.

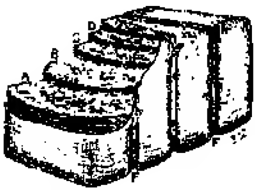

FIG. 7.—BALE OF COTTON, PARTLY OPENED.

Sand, leaves, pieces of the seed pod and, of course, bits of the seed husk or skin pass through the gins, and form parts of the impurities that the cotton contains when it is received into the mill, all of which must be eliminated before the cotton can be manipulated to the best advantage.

Baling. After the fibres have been torn from the seeds they are carried by air currents, lattices, or manual labour to a press, and there made into compact bales, chiefly of a rectangular form, but sometimes in a cylindrical shape. High pressure is used in squeezing the mass of cotton into a compact mass, and as it is an intermittent process, the bale, when opened in the mill, presents a series of layers or slabs of cotton as roughly sketched in *Fig.* 7. It is with this type of cotton that our mills have to deal, and we must now give our attention to the many problems involved in turning this hard slabby mass of raw cotton into yarn.

Requirements in a Textile Fibre. To transform a mass of fibres into a continuous yarn suitable for weaving or other purposes certain properties are

necessary or desirable in the fibres. They must be clean; open; pliable; elastic; fine or thin; possess some degree of strength; have the property of cohesiveness; uniformity in length; and be reasonably durable. If a slab or piece of the cotton be taken from a bale and examined, it will be seen that it is not clean or open. The fibres are matted together, and so some degree of cohesiveness is exhibited here. On separating the fibres they will be found to be relatively short, and not particularly uniform in length. The single fibre is pliable and very thin indeed, but easily broken. The fibres are durable, as indicated by the vast amount of cotton articles in daily use. From this generalization, the cotton fibre would scarcely appear to be one that would be suggestive of use as a textile fibre, and as a matter of fact it must have been very long after many other fibres had come into general use before the manipulative ability of a civilized people enabled cotton to be used for textile purposes. The fact that the utilization of this apparently insignificant fibre has become one of the greatest industries of the world is due to mechanical methods.

Lengths and Diameters of Cotton Fibre. In a practical sense the manipulation of cotton in the mill is based on the fibres having some definite average length, so that we speak of cotton being 1 in. or 1½ ins. long. This length, however, is not truly an average one, for whilst there may be a few fibres a little longer, there will always be a large number that are much shorter, the variation ranging from full length to as low as ¼ in. in almost all kinds of cotton. The diagram in Fig. 8 gives some idea of the lengths of various cottons, and

the cross curve serves the same purpose for the diameters. The long Sea Island cotton is the finest staple, whilst the short Indian cotton has the coarsest fibre.

Strength of Cotton Fibre. Numerous tests have been made of this factor. The strength naturally depends upon the amount of cellulose in the cell

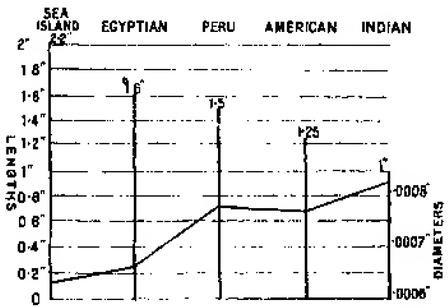

FIG. 8.—AVERAGE LENGTHS AND DIAMETERS OF COTTON FIBRES

wall of the fibre, and as this is a varying quantity in all cottons, and even in any single fibre throughout its length, it is only possible to generalize on the matter. Sea Island cotton appears to be the weakest, and Peruvian the strongest fibre, though both Dhollerah and Comptals Indian cottons have been found even stronger than Peruvian. Greenwood, at the Manchester Technical College, found that Sakels cotton varied from nothing up to 11 grammes (169·4 grains) and in 200 tests gave an average strength of 5·85 grammes (90 grains).

Cotton Under the Microscope. It has been shown that the cotton fibre is short, thin and weak, and if a fibre be examined under the microscope it will be found to consist essentially of a single tube or cell closed at the outer end and growing from the surface of the seed. The walls of the tube are very thin, and consist of an outer skin, then a deposit of cellulose and an internal lining of endocrome or colouring matter. The thickness of the cellulose wall is not uniform, so that when the cotton pod ripens and bursts, the thin-walled tubes or fibres rapidly dry and collapse in an irregular manner. This produces an appearance of a very irregular twist in the fibres, giving them a rough surface in place of the smooth cylindrical surface which they have before they are dried. "Natural twist" is a term frequently used to designate this peculiarity of the cotton fibre. Though microscopic in character it is a valuable feature in cotton, inasmuch as it enables the fibres to offer a frictional resistance to movement when in contact with each other. The frontispiece indicates the usual appearance of cotton fibres, and also their sections as seen under the microscope.

CHAPTER II

COTTON MILL PROCESSES

Condition of Bale Cotton. Raw cotton, as it arrives in the mill in highly compressed bales, is in a compact condition, and contains various kinds of impurities such as sand, soil, bits of leaf, seed scale, and cotton that has been stained in various

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ways. Also, there are innumerable short fibres as well as large numbers of small entanglements as if several fibres had become knotted together. All this suggests that the cotton should be cleaned and the short and knotty fibres eliminated. As all the impurities are embedded in the mass of fibres, cleaning requires that the cotton should

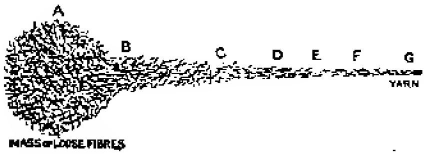


FIG. 9.—MASS OF LOOSE FIBRES DRAWN OUT INTO YARN

first be opened thoroughly—if possible so opened as to separate every fibre from its fellows. When this has been done the cotton is still a mass of loose fibres, so that, accompanying the opening and cleaning processes, the fibres must be brought into some kind of ordered condition.

The first ordered condition in cotton spinning is forming the loose cotton into a fleece and rolling it up into a lap. This lap has then to be reduced to a very small size, such as is seen in a piece of yarn.

In Fig. 9 is shown a mass of fibres drawn out to a fine thread of yarn by hand, and it will be observed that the few fibres at *G* are simply the result of a gradual *drawing out process* from the mass of fibres at *A*. To give the few fibres at *G* sufficient strength for some practical purpose, they are twisted to make them into a compact yarn or thread.

All the above processes, in a cotton mill, are

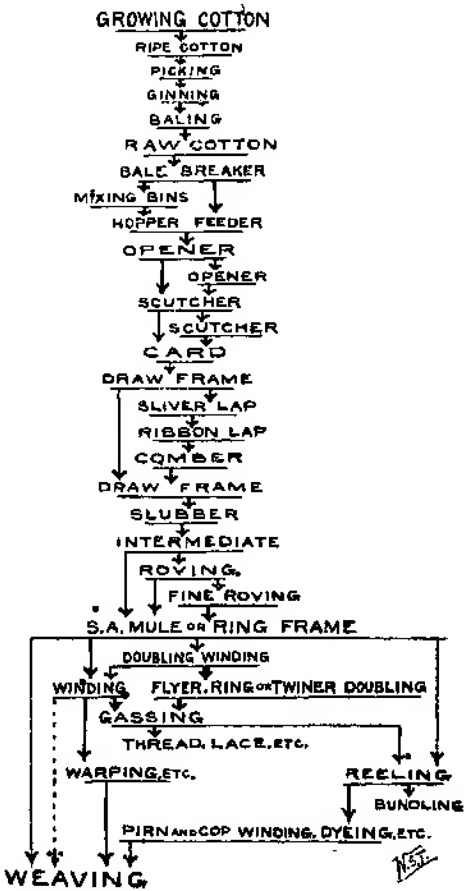


Fig. 10.—Sequence of Cotton Preparing and Spinning Processes.

done by machinery, and involve *opening*, *cleaning*, *drawing*, and *twisting* machines. During these processes the cotton is changed from the slab masses of the bale to open fluffy cotton, then gathered together into a soft thick fleece and rolled up into a *lap*, and again opened out and spread into a long, wide, and very thin *web*, which is so thin that it can be gathered together into a rope form called a *sliver*. The sliver is drawn out into a gradually decreasing thickness called a *roving*, and ultimately this roving is drawn sufficiently fine that it can be twisted or spun into *yarn*. The series of machines for performing these operations are shown in Fig. 10. The order of the machines is indicated by arrows, and it will be seen that alternate methods are given, this depending upon the kind or quality of yarn that has to be produced. Variations in the sequence of machines are to be found in practice, some of which are due either to a mere question of taste or to special qualities of yarn or special cottons.

The *departments of the mill* are usually as follows: Bale room, mixing room, scutching room (often called blowing room), card room, and spinning room.

CHAPTER III

PRINCIPLES AND ELEMENTS OF COTTON SPINNING

Moving Cotton from Place to Place. Bale cotton, on arriving at the mill, is usually unloaded by a hoist and carried into the bale room on hand trucks, small trucks on rails, trolleys on overhead rails, or even by manual labour. From

their position in the bale room, the bales are moved to some clear space and there opened by breaking

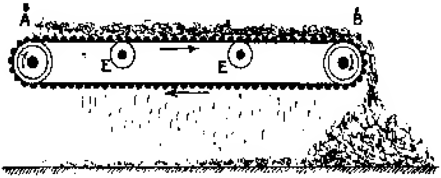


FIG. 11.—LATTICE CONVEYOR.

the iron bands by which they are bound and removing the jute covering. Every particle of this cover must be picked off before beginning to interfere with the cotton. From this point the cotton begins its passage through the mill. The following sketches will illustrate the methods adopted to transfer the cotton, in its various conditions from point to point.

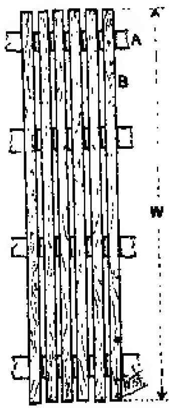


FIG. 12.—ILLUSTRATING CONSTRUCTION OF LATTICE.

Lattices. A common method of transport is by means of a travelling lattice as in Fig. 11. Cotton put on at *A* is carried to *B* and there deposited as shown, or it may be dropped into a machine or may be carried forward by other means to the desired point.

The lattice consists of a closely arranged series of wooden bars as at *B*, Fig. 12.

These bars are screwed or otherwise fixed on to leather bands *A*, and there is usually a space left between consecutive wooden bars. As a lattice is not a rigid element, it moves with a certain amount of vibration, and this causes some of the loose elements in the cotton to fall through the spaces between the bars. In some cases this may be undesirable, so a sheet of closely woven material is then placed at the back of the bars to close up the spaces.

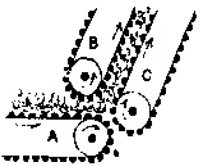
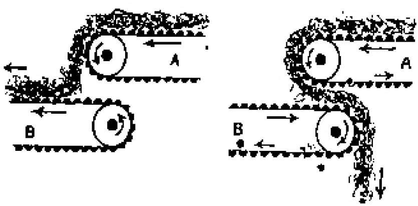


Fig. 13.—Horizontal Lattice Conveyor Delivering to Pair of Inclined Lattices

In Fig. 13 the cotton is being taken from the end of a lattice *A* to a pair of other lattices *B* and *C*, which carry it in an upward direction.



Lattice *B* continues transport to the left.

Lattice *B* unloads cotton below the end of *A*

Fig. 14.—Pair of Lattices for Through Transport or Intermediate Dumping.

The inclination of this pair of lattices *B* and *C* may be anything from a vertical to a horizontal position, but the lattice *B* becomes unnecessary as the lattice *C* approaches a horizontal position.

Two examples of lattices are shown in Fig. 14. In the left-hand diagram, lattice *A* is carrying the cotton and transfers it to lattice *B*, which continues the movement in the same direction. If, however, the cotton is not required to be carried farther, the motion of lattice *B* is reversed and, as in the right-hand diagram, the cotton is then delivered over the end of lattice *B*.

It will easily be seen that these flexible lattices can be used in any direction even at right angles to each other.

Fig. 15 shows material fed through a trunk from a room above, falling on to a lattice *L*, which carries it away from this point.

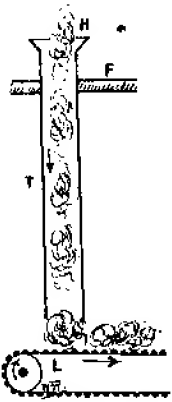


FIG. 15.—TRUNK FROM ROOM ABOVE DELIVERING ON TO LATTICE CONVEYOR.

Lattices are also used to carry forward other than the raw or open cotton. The rolled up fleece of cotton, already mentioned and called a lap, requires to be unrolled, and the unrolled part must be supported or it will fall to pieces. Fig. 16 shows how this is done by resting the lap on a travelling lattice, the frictional grip of which holds the lap and carries it forward, thus unrolling the lap. The lattice supports the portion unrolled.

In some cases blocks or lumps of cotton require to be fed in a certain manner, and spiked bars are fixed on to the lattice as shown in Fig. 17. The

cotton is placed on lattice *A*, which carries it to the inclined lattice *L*. The spikes *S* in this

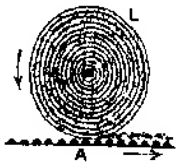


Fig. 16.—Travelling Lattice Unrolling and Supporting Cotton Fleece or Lap.

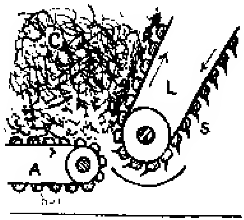


Fig. 17.—Inclined Lattice with Spikes for Opening and Elevating Cotton.

lattice carry the cotton upwards, and in doing so pulls away the cotton from the bulk, and so breaks it up into smaller portions.

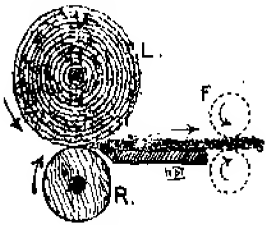


Fig. 18.—Lap Unrolled and Fleece Carried Forward by Rollers.

Rollers. Rollers are used extensively in carrying cotton forward in the various machines. The sketch in Fig. 18 gives two examples of the method. The lap *L* is unrolled by frictional contact with

the revolving roller *R*, on which it rests. As the lap unrolls, the fleece is taken forward by a pair of rollers at *F* revolving in the direction shown. In some conditions of the cotton, such as being very thin or when some action is tending to pull it asunder, the fibres must be carried forward and supported by several rollers, such as in Fig. 19.

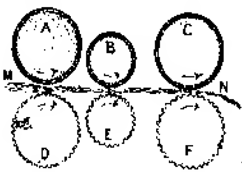


FIG. 19.—TRAIN OF ROLLERS HANDLING WEAK FLEECE

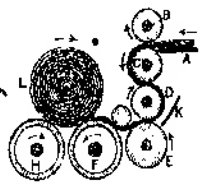


FIG. 20.—ROLLERS CONSOLIDATING FLEECE AND ROLLING A LAP

Another example is given in Fig. 20, showing how rollers guide the cotton from its loose condition at *A* until it is rolled up into a lap at *L*.

Pneumatic Conveying. Currents of air are used to a considerable extent in carrying cotton from one place to another, but this, of course, can only be done after the cotton has been opened out somewhat. If a suction fan be placed at one end of a tube or trunk it sucks out the air in the trunk and, by admitting air at the other end, there is established a continuous current of air through the trunk. If loose cotton be allowed to enter the trunk it is carried along with the current of air, and may thus be transported over considerable distances. Manual labour in transferring cotton between machines may be eliminated by connecting

the latter by trunks with suitably placed fans. The efficiency of this pneumatic system of carrying cotton either along trunks or within a machine itself, depends firstly upon the fan, secondly upon

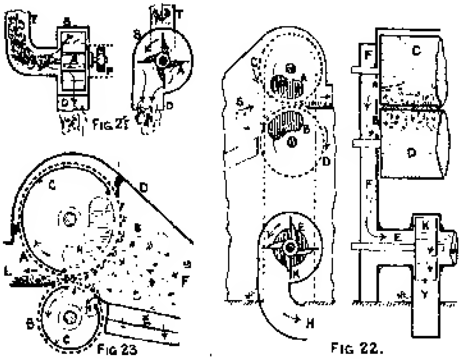


FIG. 21.—USE OF SUCTION FAN TO DRAW COTTON THROUGH A TRUNK.

FIG. 22.—PNEUMATIC SUCTION APPLIED TO A MACHINE.

FIG. 23.—ROLLER CAGES PRODUCING A FLEECE FREE FROM DUST AND SHORT FIBRES.

the condition of the cotton, and thirdly upon the distance the cotton has to travel and the bends in the trunk.

Fig. 21 shows a suction fan which draws air out of the trunk *T*. If cotton be admitted it travels in the direction of the arrows and is delivered along the trunk *D*. It will be noted that the fan *A* could have a trunk *T* placed on either side of it, and thus draw air from both sides.

An example of the use of a fan in a machine is given in Fig. 22. The fan *K* communicates along the tube *E* with a casing *F*, and this in turn contains openings *A* and *B*, which form passages into the revolving cages *C* and *D* respectively. The tube *I*, from the fan *K*, is in connection with the other end of the cages *C* and *D* in the same manner as that shown. If the fan is in operation, the cages revolving, and loose cotton floating about in the space *S*, this cotton will be sucked or drawn on to the cages along with the current of air set up. The apertures in the cages are too small for the cotton to pass through to the fan, so it adheres to the surfaces of the cages until it passes between them and is delivered as a loosely formed fleece. All dust and short fibres will pass through the cages and be ejected at the outlet of the fan at *H*.

An enlarged view of these cages is shown in Fig. 23. The air current carrying the cotton must be confined to a certain direction so that the cotton is deposited uniformly on a given part of each cage. This is effected by internal dampers *C*, which cover up large portions of the cage surfaces; in addition, leather flaps are applied to cut off undesirable draughts and leakages of air.

Opening and Cleaning. If a piece of a slab of cotton from the bale be shaken over a clean sheet of paper it will be seen that very little dirt falls out of it. If, however, the same piece be opened by hand into a loose fluffy condition, still over the sheet of paper, dirt will fall out, and dust will appear about the cotton. Opening and cleaning are, therefore, two closely connected processes, and one is almost always associated with the

other. An opening process is always the essential factor before cleaning can occur.

Mechanical Methods of Opening. The opening of the bale cotton was formerly a laborious manual job, and was done very imperfectly, hence arose the necessity for allowing the cotton to rest in a stack for some considerable time in order to permit air and moisture to permeate the material and soften the partially opened hard tufts. The operation is now done by machinery, and in the majority of cases it is quite unnecessary to stack the opened cotton before passing it forward. The earlier machines were a great improvement on hand opening, but passing the cotton through successive pairs of strong spiked toothed rollers, and having each successive pair of rollers running at a higher surface speed, did little more than loosen and enlarge the slabs of cotton. This method even required hand feeding and pulling asunder of the cotton on the feeding lattice, and a stack was necessary to condition it.

Bale cotton is now opened by the mechanical elements shown in Fig. 17 (p. 20). If a bulk of bale cotton be placed on the lattice *A* it is carried into contact with the spiked upright lattice *L*, the teeth of which pass through the slabs, drag out the fibres, and carry them upwards where they can be removed.

In Fig. 24 we have a further opening effect illustrated. It is possible that the spikes of the inclined lattice will carry slabs or large lumps of cotton or some spikes will be more charged with cotton than others. This difficulty is partially overcome by arranging a beater or evener roller *E* near the upper end of the lattice. By adjusting

this beater to the spiked lattice any superfluous cotton will be beaten off and will drop back into the bulk below. The opened cotton is stripped from the spikes by a beater C, and may be operated upon immediately by subsequent machines.

The next sketch, Fig. 25, shows an opening element consisting of a cylinder P covered with

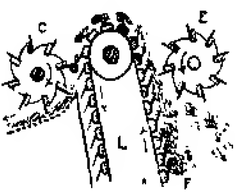


FIG. 24.—ILLUSTRATING USE OF EVENER ROLLER AND STRIPPING BEATER.

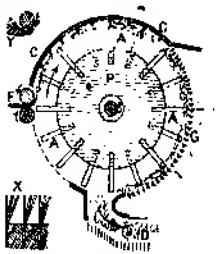


FIG. 25.—PORCUPINE CYLINDER AND CASING.

iron blades A projecting from its surface. The cylinder revolves rapidly on its shaft S, and as the cotton is fed between the rollers F the blades strike it and carry it round within the casing or cover C. The blades vary from a straight radial through varying bent forms, as at X, so that the whole cylinder is covered with these projecting knives or blades. From this appearance, such an opening organ is termed a *porcupine cylinder*. The cotton, in passing from the feed rollers F, is impeded by snugs or projections on the inside of the cover, and so receives a further beating by the cylinder blades. During its further passage it meets with a series of bars G, with openings

between the bars, and here it is dragged over the sharp edges of these bars and further opened. At the same time the grid-form of the bars enables the heavy impurities to be driven out into receptacles placed to receive them. The cotton, on reaching the lowest portion of the cylinder, has been opened sufficiently to be carried by a current of air (created by a suction fan) along *D* and on to other parts of the machine.

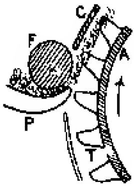


Fig. 26.—Alternative Form of Opening-Cylinder and Feed.

A variation from the form of cylinder in Fig. 25 is given in Fig. 26, in which the teeth are shorter and of cast iron. Instead of two feed rollers as at *F*, only one roller need be used, the other being substituted by the shaped

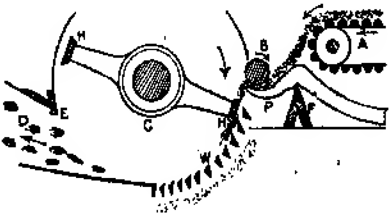


Fig. 27.—Opening by Blades on Beater Arms.

end of a lever as at *Y* in Fig. 25, and at *P* in Fig. 26.

Another type of opening element is given in Fig. 27. This consists of long steel blades fastened to arms, an end view of which is shown in the sketch.

The blades H may be two or three in number; they are inclined on the edges and strike very rapid blows on the cotton as the beater C revolves. These blows detach tufts of cotton as it is fed between the roller B and the pedal lever P. The cotton is thus opened out, and in its passage it is dashed against the grid or bars W, which still further loosen it, and enable some impurities to drop out between the bars into receptacles underneath. A suction fan produces a current of air

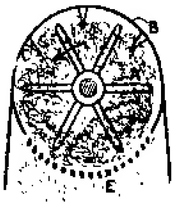


FIG. 28.—OPENING BY ROTARY BEATERS ALONE.

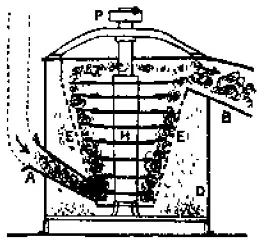


FIG. 29. VERTICAL CONICAL OPENER.

which carries the opened cotton in the direction D, where it may be deposited on the cages as already explained.

Yet another class of opening element is illustrated in Figs. 28 and 29. In Fig. 28 the beater A consists of arms projecting from a shaft which revolves at a high speed within a casing, the lower part of which is in the form of a grid E. Cotton is placed within the casing through a door, and the armed beater set to work. The cotton is well beaten up, and after an interval varying according to the degree of opening and cleaning required,

the cotton is taken out. The dust and dirt are knocked out by the arms and the projections C on the cover B, and fall through the grid E. It will be noted that the cotton is not fed by rollers, nor is it struck from the grip of rollers or pedals.

A similar type of opener in which the cotton is not struck from a holding position is shown in Fig. 29. Here the cotton is fed through a trunk to an enclosed casing in which revolves a conical beater. This beater is built up of discs of steel with blades projecting from their outer edges similar to those of the porcupine beater already described. The small discs of the beater are at the bottom, and the cotton on entering the casing is at once operated upon by the high speed blades and is opened out. Owing to the higher peripheral speed of the larger diameter discs in the beater a current of air is set up from the bottom to the top of the machine, and an additional suction effect is provided to draw the cotton along the passage B. As the cotton becomes more open at the lower end of the beater the current of air raises it and brings it into contact with the larger diameter discs, where it is opened further so that the current of air can raise it yet higher until ultimately it reaches the highest point of the beater and passes along the passage B for further treatments. Grids E surround the conical beater, through which impurities are driven by centrifugal action or fall by gravity.

Although the cotton has been opened to a considerable extent, as compared with its condition in the bale, it is by no means open or clean enough for our purpose. More refined methods now succeed those already given, and in Fig. 30 is shown

a sheet of cotton L fed between a roller F and a fixed plate D. A cylinder T covered with saw teeth is revolving rapidly, and as the cotton goes over the point N the saw teeth pass through it and take it away in very small open fleecy tufts. Motes and other impurities are knocked off the teeth by the steel strips M, and other impurities and short fibres pass through the gridded casing

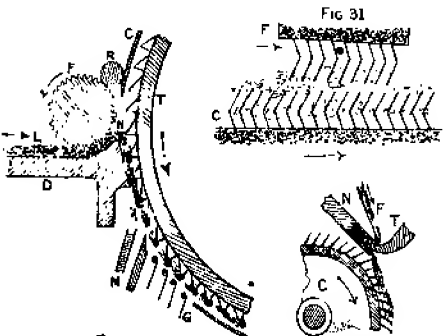


Fig. 30.—Opening and Cleaning Action of Taker-in.

Fig. 31.—Opening and Cleaning Action of Cylinder and Flat.

Fig. 32.—Opening and Cleaning Action of Comber.

G. This action may be compared with that of the saw gin (Fig. 6). A further refinement in opening and cleaning is carried out by passing this cotton between two surfaces covered with innumerable fine points of wire, the two surfaces being set very close to each other as in Fig. 31.

The part *C* travels very quickly, whilst *F* moves very slowly. It is readily seen that the cotton will be opened out into a state of individual fibres, and this is done so effectively that for most purposes the cotton may be considered to be sufficiently opened and cleaned ready for other processes. There are still considerable quantities of neps or very minute knotty entanglements of fibres, and also a large amount of short fibres in the cotton, so for high class work another opening action is introduced as illustrated in Fig. 32.

A cylinder *C* (only a portion is shown) carries rows of needles. Cotton is fed along *F*, and at intervals is gripped or nipped between the ends of *N* and *T* and held firmly. The needles of the revolving cylinder pass through the protruding cotton and open it thoroughly, and also clean it by the combing action of the needles which remove all the short fibres and neps.

Mixing Cotton. It has already been mentioned that cotton is stacked after being opened from the bale and before passing it through any further opening process. In the early days of the industry the main object of this stacking was to allow the cotton to recover a more natural condition after its severe pressing in the bale, particularly as hand-opening separated the cotton very imperfectly. In addition to this, it was found, as varieties of cotton multiplied, that the cotton was not uniform in colour, staple, cleanliness, etc., and also that varieties of cottons could be combined to obtain tints, strength, cheaper or dearer yarn, etc. All these factors make it necessary to mix cottons thoroughly in order to obtain uniformly the desired product. A stack of cotton

is built up of layers of various bales and cottons, and is then conditioned or allowed to rest for a period. When used, the cotton is raked down from top to bottom of the stack, and the mixture is passed through the opening process.

Drafting or Drawing Processes. We have seen that an almost solid block of cotton fibres in the form of a bale ultimately becomes a long thin yarn or thread. Clearly the fibres have been drawn out to obtain this effect. If a piece of elastic is subjected to a pull it will become longer and thinner, i.e. it has been drawn out. It will not remain in this condition, but if a group of cotton fibres are pulled gently in the same way the individual fibres will slide over each other and we can thus draw out the fibres to a longer length and a finer or thinner condition. Owing to the shortness of the fibres, this drawing out can only be done gradually and in stages. The opening methods have shown that a short length of cotton fed to the opening organ can be beaten into a long length. Currents of air will also draw the opened fibres into longer lengths, as we have seen in the preceding notes. On examining this drawing out action, we see that it is effected by moving the fibres forward more quickly than they are delivered. Revolving cylindrical surfaces are the chief means of obtaining this attenuation of the fibres. These are known as drawing rollers, and one pair of rollers feeds the cotton to another pair of rollers which run at a higher surface speed. Fig. 33 gives a general idea of this method. The bottom rollers, *D*, *E*, *F*, are fluted in order to grip the cotton and they are driven positively. The top rollers, *A*, *E*, *P*, are driven by friction through

contact with the cotton that is being carried forward. The surface speed of *E* is higher than that of *D*, and the surface speed of *F* is higher than that of *E*. Cotton is fed at *M*, and is taken forward until it reaches *E*, when it at once begins to be taken forward at a quicker rate, so the fibres are drawn asunder or slide over each other. This straightens them and tends to set them parallel to each other. A similar action takes place between the roller *F* and *E*, because *F* runs much more quickly than *E*. The consequence of this action is that the cotton delivered at *N* is thinner than that fed at *M*, and also that the fibres are in a straighter and more nearly parallel state.

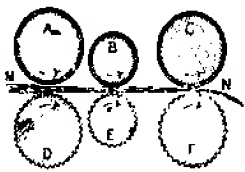


FIG. 33.—DRAWING ROLLERS PRODUCE A LONGER, FINER THREAD

Doubling. The efforts to bring the chaotic mass of fibres into some ordered condition, such as a fleece, lap, web, sliver, roving, and yarn, are successful in their respective objects, but there is an unusual degree of irregularity in the thick and thin places which abound in all these stages. Mechanism has not yet been devised to obtain regularity by a single process, hence uniformity has to be obtained by the costly method of repeating processes. Several laps, slivers, rovings, or yarns are "doubled" or combined together so that there is a chance of thick and thin places neutralizing each other. The more slivers that can be doubled together the greater the chances of

regularity, though there is always the possibility of a run of thick or thin places coming together. In general the method of doubling results in regularity.

In Fig. 34 three laps are shown. If they are all unrolled together and carried forward they will all be superimposed at *A*, and in this condition the thick and thin places will be partially neutralized. The three thicknesses pass through the machine *B* and emerge at *C* as one thickness equal to the thickness of one of the original laps

Fig. 34.—Doubling Laps to Obtain Uniformity.

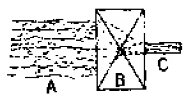


Fig. 35.—Doubling Slivers to Obtain Uniformity.

and much more regular in thickness than any one of the original laps.

In the same way the slivers in Fig. 35 are combined at *A*, pass through the machine *B*, and emerge at *C* in a more regular condition as a single sliver. It will be seen from this that *doubling* is a process the very opposite of *drawing*, so far as attenuation is concerned.

Ordered Forms of Cotton. Cotton can be fed to a machine continuously for relatively long periods, and consequently the machine will deliver the cotton continuously without a break. When the cotton is given an ordered form such as a fleece, sliver, roving, etc., it requires to be transferred to other machines, and must, therefore, be in a form and size suitable for carrying about by manual labour.

In the case of the fleece it is rolled up into a lap weighing about 30 lbs., and can be carried to other machines.

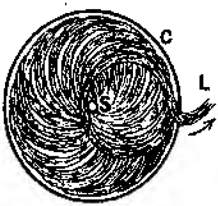


FIG. 36.—PLAN VIEW OF SLIVER COILED IN A CAN.

The sliver is in the form of a continuous rope of very loose fibres, about ¾ in. to 1 in. in diameter, and is coiled up into a can something like that shown in Fig. 36. The coiling commences at the bottom of the can *C*, and the latter is gradually filled by the sliver being coiled as shown. By withdrawing the end *L*, the whole of the sliver can easily be drawn out of the can.

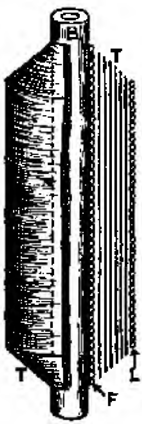


FIG. 37.—PARTIAL SECTION OF FULLY-WOUND ROVING BOBBIN.

As the sliver is drawn down to a thinner diameter it is too light and weak to be coiled into a can, so it is wound on to bobbins. These bobbins (roving bobbins) consist of a wooden barrel, and the roving is wound on this in cylindrical layers as in Fig. 37. The bobbin barrels have no end flanges, so the ends of the winding are built up in a conical form as at *T*; this enables the bobbins to be carried from one machine to another without damaging the delicate roving. The final form when the roving has been spun into yarn is the cop.

Twisting. It will readily be seen that when a series of short fibres, such as cotton, have been drawn out to a very small diameter, say one-sixteenth of an inch, with the fibres all lying in a fairly straight position lengthwise of the roving, the roving will be very weak and easily broken. It is so weak that it would scarcely be possible to wind it on a bobbin in spite of the very delicate adjustment of the mechanism used for that purpose. If, however, this weak roving be given a few twists it is strengthened considerably by binding the fibres together. Frictional resistance between the fibres then prevents them from sliding over each other. When the roving has been reduced by "drawing" to the requisite thinness, in stages, it receives a final twisting consisting of many twists per inch which transforms it into "yarn." This final twisting is termed "spinning," whilst the other twisting mentioned is merely incidental, to enable the roving to be unwound from one bobbin and wound on to another.

Methods of Twisting. Experiments with narrow tape are useful to illustrate the twisting effect of various pieces of mechanism. Take a short spindle as in Fig. 38, with a weight *W* at one end. Make a slit at the other end, or use a ring to fit tightly over the end, to hold the tape. Then if *S* be held suspended by the tape and the weight *W* be revolved, the tape becomes twisted—one twist for every revolution of the spindle. If this twisted portion be now wound on to the spindle and a further length of material be taken, another length of twisted tape is produced. Substitute a roving for the tape, and we have a very ancient spinning process.

It will be seen that the end of the tape in Fig. 38 could be fastened anywhere along *S*; it is a mere convenience to fasten it to the end. At *A*, in Fig. 39, the material is shown fixed to the middle of the spindle *S*. The spindle is also shown driven by a band and wharve. If the material is now passed through an eyelet at the end of an arm *E* fixed to the spindle *S*, the other end *X* being held in one position, the revolution of the spindle will twist the material between *A* and *X*. The arm *E* may be bent to any shape without altering the action, and in Fig. 39 (C) the arm *E* is shown bent—yielding a recognizable form of flyer used in the earliest mechanical methods of spinning, the principle of which is still used extensively in cotton mills for putting twist into rovings and yarns. The arm *E* can be pendant or inverted.

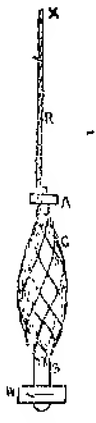


FIG. 38. ILLUSTRATING THE PRINCIPLE OF FLYER TWISTING.

Although Fig. 39 shows only one arm as the essential feature in twisting, it will be realized that as this arm revolves it will be unbalanced, so another arm is placed on the opposite side. A further feature to be observed is that, as the spindle revolves, the arm *E* in Fig. 39 (C) tends to fly outwards by centrifugal force. This limits this type of spindle to comparatively low speeds, and is thus an important limiting factor in production wherever it is used.

A modification of the flyer type of twisting is

seen in the ring and traveller method. Referring to Fig. 40, the material *Y* to be twisted comes from the rollers and is threaded through a bent piece of wire *T* (called a traveller) which clips over a fixed ring *R*, and is free to move around the ring. From the traveller *T* the material passes to the

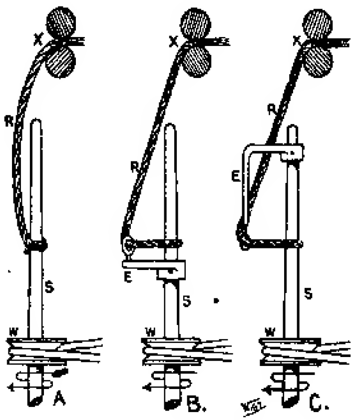


FIG. 39.—THE EVOLUTION OF THE SIMPLE FLYER.

spindle *S*. When the spindle revolves it tends to wind on the material *Y*. As this material is only being delivered at a certain uniform rate, the pulling effect on *Y* would break the material were it not for the fact that the loose traveller yields to the pull and begins to move round the ring *R*. For every revolution that the traveller makes round the ring there is a twist put into the material

Y. There is practically no limit to the speed at which the traveller can be driven round the ring.

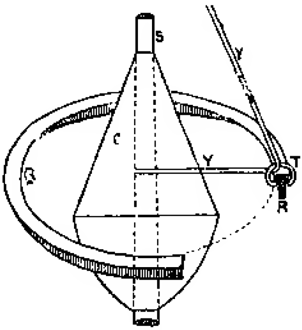


FIG. 40.—RING AND TRAVELLER TWISTING MECHANISM.

The next illustration, Fig. 41, represents an extremely old but a very ingenious method. The drawing represents a spindle *S* on which some material has been wound. This material *Y* is continued up the spindle to the point *P*, and from here goes to the rollers beyond *X*. As the spindle revolves it naturally attempts to wind on the yarn *Y*, but owing to the inclined position of the spindle and the fact that the spindle is tapered to a fairly fine point the yarn begins to slip over the end, and every revolution of the spindle results

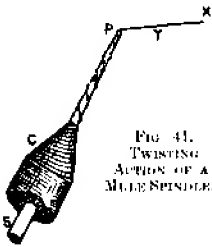


FIG. 41. TWISTING ACTION OF A MULE SPINDLE.

in this slipping over of the yarn. Each time the yarn slips over, a twist is put into it, so that for every revolution of the spindle a twist is put in the material Y. As the spindle is a perfectly plain piece of cylindrical steel with a wharve for driving it, there is in this case also practically no limit to the speed of the twisting process.

Winding. In rolling a fleece into a lap the method shown in Fig. 20 (p. 21) is adopted. As the speed at which it is wound up is uniform with the speed at which the fleece is delivered it is simply turned round at the rate of the rollers on which it rests.

Coiler winding has already been explained (p. 34), and this speed is also uniform.

On winding material on to a bobbin or cop in cotton machinery a different set of conditions exists. Let S, Fig. 42, be a spindle or bobbin on to which is to be wound material uniformly delivered from X. The speed of the spindle S must be such that it will wind on the material Y at exactly the same speed as that at which it is delivered by the rollers X. As the material is put on in layers the bobbin becomes larger in diameter, so that ultimately it reaches the large diameter F. This large diameter must also run at a speed that will wind on exactly at the rate delivered by rollers X, but one revolution of F will wind on very much more than one revolution of S. To wind on at F, therefore, we must have the *surface speed* of F precisely the same as it was at S. This clearly means that the full bobbin must revolve much slower than the empty bobbin in order to wind on the material. The variation, of course, must be made gradually as each layer

is added from the empty bobbin S to the full bobbin F. This is equal to saying that in winding on material in any form the surface speed of the surface on which the material is wound must be uniform. To obtain a uniform surface speed on a varying diameter we must vary the rate of revolution.

Methods of Winding. Two methods are adopted in cotton spinning machinery to vary gradually

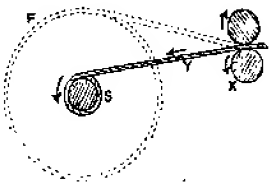


FIG. 42.—SURFACE SPEED MUST REMAIN CONSTANT AS THE WINDING DIAMETER INCREASES.

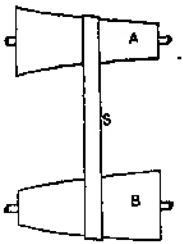


FIG. 43.—CONE DRUMS FOR VARYING SPEED.

the rate of revolution of a bobbin or spindle. One method is by means of cone drums as shown in Fig. 43. If the cone drum marked A revolves at a uniform rate it will drive the cone drum B at a varying rate according to the position of the strap connecting the two drums. By suitable mechanical arrangements the strap S can be moved gradually from one end of the cone drums to the other as a bobbin is enlarged by the addition of layer upon layer of material.

The other method is by means of a quadrant as

sketched in Fig. 44. The object is to drive a drum *D* at a varying speed. Let *Q* be a bar centred at *C*; at *A* attach a hook to which is fastened one end of a chain which is wound several times round the drum *D*. If we now cause the bar *Q* to move through part of a circle to the dotted position, and at the same time

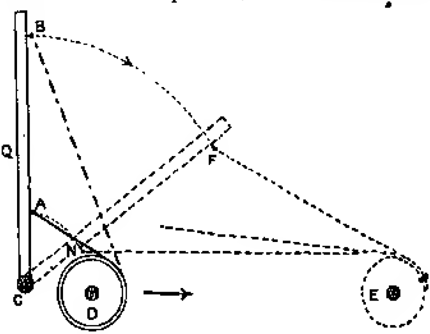


FIG. 44.—QUADRANT GEAR FOR VARYING SPEED.

move the drum *D* to the position *E*, we shall find that a length of chain exists between the new position of *A* at *N* and the new position of the drum at *E*. This length of chain has clearly become unwound from the drum, and in unwinding it must have caused the drum to revolve.

If the chain attachment at *A* is moved upwards along the bar Q in a series of steps and, at each step, the bar moves to the dotted position at the same time that the drum *D* moves to *E*, it will be found that the amount of chain unwound from the drum will be less at each step. In Fig. 44 the

extreme upward movement of the chain attachment is to the point *B*, and it will be seen that when *B* moves to *F*, and the drum *D* moves to *E*, the length of chain unwound is considerably less than when the chain is attached to the lowest point of the bar at *A*. The drum *D* is thus made to revolve at a varying speed, depending upon the position of the chain between *A* and *B*, being quickest when the chain is at *A* and gradually becoming slower as the hook travels up the bar to *B*. By arranging suitable gearing on the shaft of the drum *D*, the spindles may be driven and, as a cop increases in diameter, its speed is reduced in the correct ratio. It may also be pointed out that as a cop is built up from an initial parallel layer to a very conical layer, the circular movement of the chain attachment on the bar gives the necessary variation to the speed of the spindle required for winding on a conical surface.

The foregoing methods of opening, cleaning, drawing, doubling, twisting, and winding are all incorporated in cotton machinery, and generally two or more of the elements are found in a single machine. The next step will be to show the various complete machines and, if the previous chapters have been read carefully, it will be a comparatively easy matter to follow the descriptions given to each machine. A host of small details, both mechanical and operative, are associated with cotton machinery apart from the main element, such as gearing, driving, amount of drawing required, sizes of rollers, setting of rollers, and adjustments of distances to set the various elements apart from each other.

CHAPTER IV

COTTON GINS

THE machine illustrated in Fig. 45 consists of a series of circular saws, *S*, mounted on a shaft at some fixed distance apart, the space between the saws being partially occupied by plates or bars *P*.

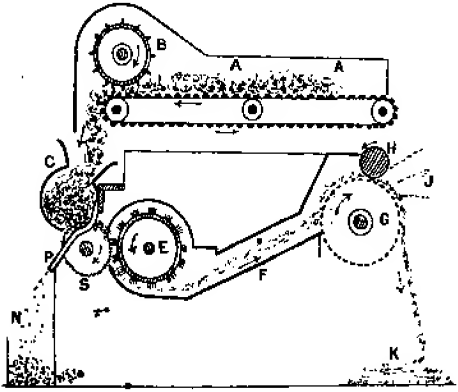


FIG. 45.—SAW GIN.

Seed cotton is fed into a hopper space *C* by lattices or by hand, and this cotton falls into contact with the projecting teeth of the rapidly revolving saws. The teeth of the saws catch on the clustered and entangled fibres, and these are carried forward, but the seeds cannot follow as they are blocked by the bars. The fibres are simply torn from

the seeds, and these latter drop through grids below. The fibres are carried round by the saw, stripped by the brush *E*, and carried by lattices or air currents to suitable repositories or to the baling press.

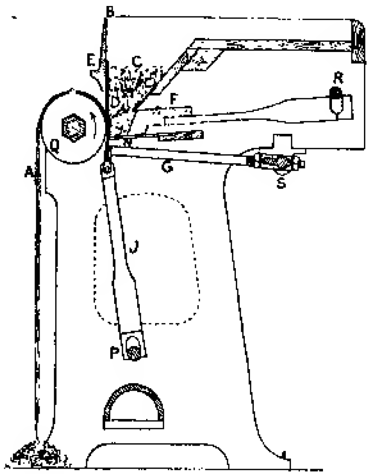


FIG. 46.—SINGLE-ACTION MACARTHY GIN.

Another gin extensively used is the Macarthy gin, a section of which is given in Fig. 46. As will be seen it incorporates the element shown in Fig. 5. The tapping effect for the removal of the seeds is obtained by the crank and lever *P* and *J*.

CHAPTER V

MIXING AND BLOWING ROOM MACHINERY

Bale Breaker. Fig. 47 represents a typical machine for breaking up the hard slabby lumps of cotton as taken from the bale. The bale cotton is fed on to the lattice *F* and carried into the hopper part *A* to the spiked lattice *B*. The roller *C*, called an *evener roller*, removes superfluous cotton, whilst the roller *D* clears or strips the cotton from the lattice spikes and knocks it on to the lattice below, whence it is taken to the mixing stacks or to the opener.

A good deal of dust is caused by the agitation of the cotton, so a fan *K* is provided to draw off the dust through the opening and trunk *L*.

Mixings. If the cotton is made up into a mixing stack, it is passed from the hopper bale opener to lattices which convey it to its required position in the mixing room. A mill generally has two or more qualities of mixings, so that the lattices are subdivided, and by reversing them or depositing the cotton on cross lattices it can be carried to any required stack or bin. Fig. 48 gives a good idea of such an arrangement. Four mixing bins are used and the cotton is carried from the bale opener to the mixing room above by vertical lattices.

Instead of lattices, the cotton may be taken from the hopper bale opener by a pneumatic system along trunks and deposited where desired.

Hopper Feeders. The loose mass of cotton in the mixing stacks, or as it emerges from the bale breaker, requires to be fed to the opener in some

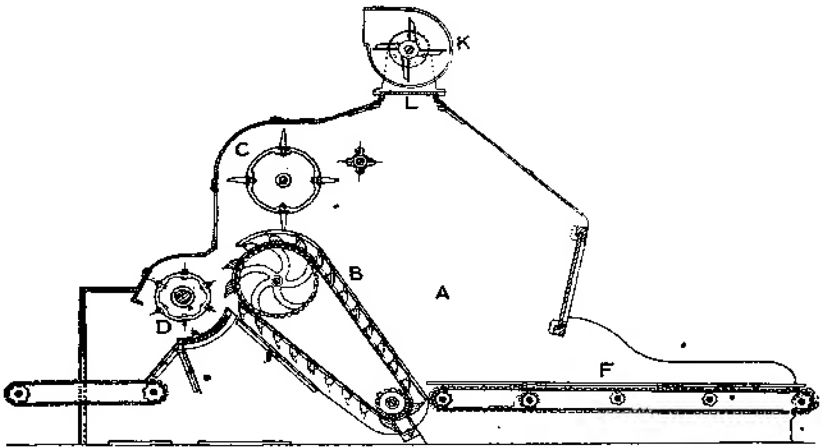


FIG. 47.—HOPPER BALE BREAKER.

regular and uniform manner. Formerly this was done by spreading a given weight of cotton over a certain length of lattice, but a hopper feeder is now used exclusively. This machine is shown in Fig. 49. The machine is similar to

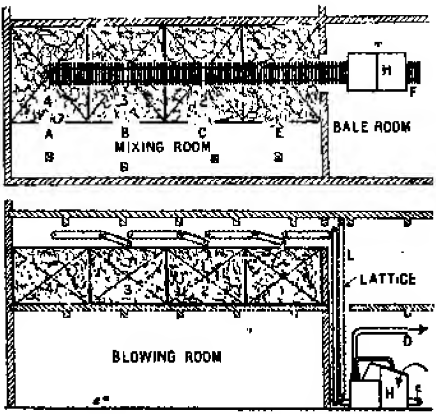


FIG. 48.—TYPICAL LAY-OUT OF MIXING BINS AND LATTICES.

the bale opener, but not so robust, and the settings are more delicate. The uniform feed to the opener takes place at *H*. A variety of details differ from those shown in Fig. 49 on comparing different makers' machines, but the type is constant. The cotton is fed by a trunk from a room above or by a lattice delivering into the hopper. Stop motions are applied so that the machine can automatically be stopped and started when full or nearly empty,

or to stop and start with the machine to which it is feeding the cotton.

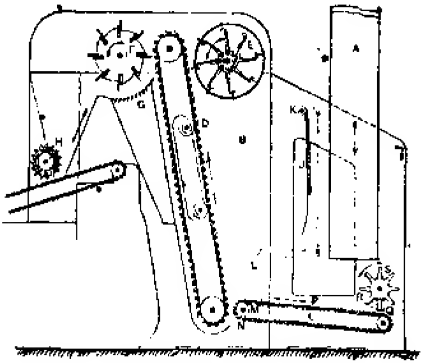


FIG. 49.—AUTOMATIC HOPPER FEEDER SERVING THE OPENER.

Openers.—A variety of opening elements have already been described, and also the means of

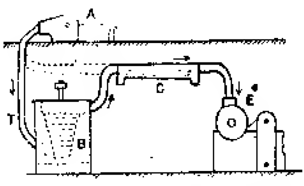


FIG. 50.—LAY-OUT OF OPENING MACHINES.

conveying cotton, so that the following drawings only need a brief explanation.

Vertical Conical Opener. The essential feature

of this machine has been given in Fig. 29 (p. 27.) The machine may be fed by hand, by trunk as shown in Fig. 50, or by lattices. The cotton may be delivered from *B*, Fig. 29, in several ways. One method is shown in Fig. 50, where the cotton is drawn along a dust trunk *C* to an opener *E*. Alternatively, the cotton may pass through one or a pair of cages. A cage and lattice of this type

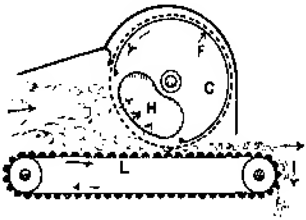


FIG. 51.—CAGE AND LATTICE FOR CLEANING AND DELIVERING OPENED COTTON.

is shown in Fig. 51. A pair of cages is similar to those shown in Fig. 22 (p. 22).

Exhaust Opener. At *E*, in Fig. 50, the cotton is fed to an exhaust opener, a more detailed view of which is given in Fig. 52. The cotton in passing down the trunk *E*, is divided, a portion going down each branch to beaters *F*, and from there through a fan *G*, which throws the opened cotton through a passage *H* towards a pair of cages. Beyond this point it may be made into a lap or be subjected to a further opening by a bladed beater, and then formed into a lap.

Horizontal Openers. The building up of a machine from the elements already described

can be clearly seen in this type of opener, as illustrated in Figs. 53 and 54. The cotton is fed through the hopper feeder to the opener lattice

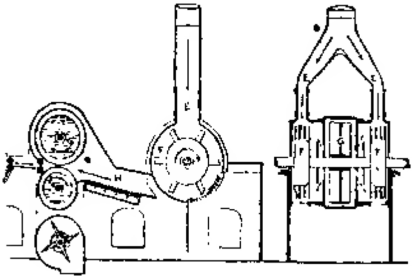


FIG. 52.—EXHAUST OPENER AND PAIR OF CAGES.

and on through the feed roller to the large porcupine cylinder beater *D*. As already described, this takes the cotton round three-quarters of the

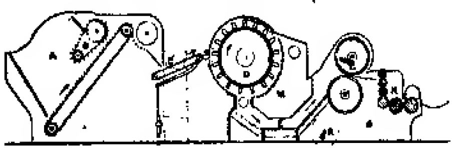


FIG. 53.—HORIZONTAL OPENER WITH SINGLE BEATER.

circumference of the cylinder, and the opened and cleaner cotton is then drawn along the passage *E* to the cages and formed into a lap at *K*, as in Fig. 53, or passed through a second beater of the bladed type and then on to the lap part, as in Fig. 54. Abundant opening and cleaning surfaces are a feature of these openers, and it may be

interesting to note how, in Fig. 55, a similar effect is obtained by a different arrangement of the passages and by striking the cotton downwards instead of upwards as in the previous example.

The elements composing various opening machines can be combined in a variety of ways, either directly or by trunks. These combinations depend upon the degree of dirt or impurities in the cotton and on the length of the staple. Long

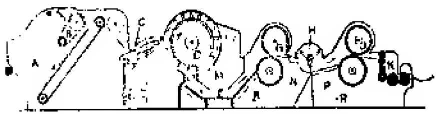


FIG. 54.—HORIZONTAL OPENER WITH PORCUPINE AND BLADED BEATERS

fibres require more delicate treatment than short fibres, whilst dirty cottons are subjected to a longer opening and cleaning process than clean cottons.

It is on the opener that the cotton attains its first ordered condition and is formed into a *lap*.

Scutchers. A scutcher is simply an opener in which, at present, a bladed beater is generally used as opening organ; more efficient operation would be obtained by using a suitable porcupine beater instead of a bladed beater. Fig. 56 gives a section through a scutcher.

The scutcher is fed with laps from the opener and not with loose cotton as in the opener. Generally four laps are placed on a feeding lattice, and as they unroll they pass in a fourfold thickness through the feed roller to the beater. This is an equalizing doubling effect. The beating action

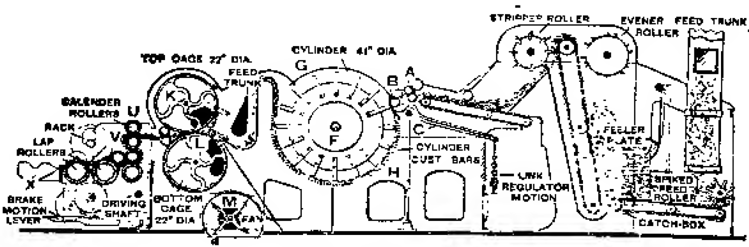


FIG. 55.—SINGLE HORIZONTAL OPENER WITH AUTOMATIC HOPPER FEEDER

has already been explained (*see* Fig. 27, p. 26) as well as other features of the machine. Fig. 56A

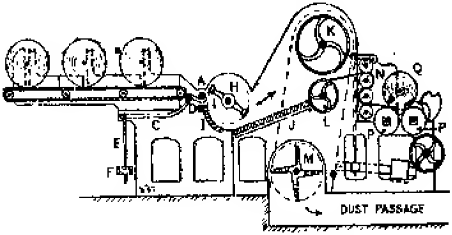


FIG. 56.—SECTION THROUGH SCUTCHER.

shows a porcupine beater instead of the usual two or three bladed beater.

Regulating Feed Motion. The cotton in the laps is imperfectly opened, notwithstanding the severe

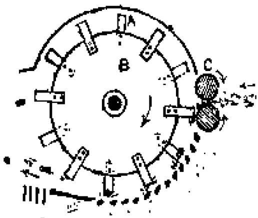


FIG. 56A.—PORCUPINE BEATER FOR SCUTCHER.

treatment to which it has already been subjected, and it is in a very irregular condition, so a special regulating feed motion is always a prominent feature of the scutcher. This motion is also used extensively on the openers but, as in so many

phases of cotton spinning, it is necessary to repeat processes before even fairly satisfactory results can be obtained.

The regulating motion, which is often called a piano motion, consists of a series of levers or pedals placed close together along the width of the machine directly under the feed roller which is in fixed bearings. The pedals are fulcrumed on a knife-edged rail, and have a long extension. As the cotton passes between the feed roller and the pedals, the thick and thin parts of the cotton cause the pedals to fall or rise, and so cause the opposite movement at their other end. These

FIG. 57.—PIANO MOTION FOR REGULATING FEED.

movements of the long arms of the pedal levers are averaged by coupling the lever ends, in pairs, by links in a descending series, so that ultimately the final link only is affected, and its movement represents the average of all the pedal movements. If the average movement shows the feed to be too thick or too thin, the final link actuates a lever which moves a strap along a pair of cone drums, and so causes a slower or a faster feed to be given in order to compensate for the thick or thin average feed. The motion is an effective one for giving regularity in the *length* of the lap, but it has no effect on the regularity of *width* of the lap. Fig. 57 shows how the irregularity of the feeding laps moves the pedal ends under the feed roller.

CHAPTER VI

CARDING

THE opening and cleaning machinery hitherto illustrated has employed very coarse, and, one might say, crude beating organs so that there is no difficulty in understanding that a very

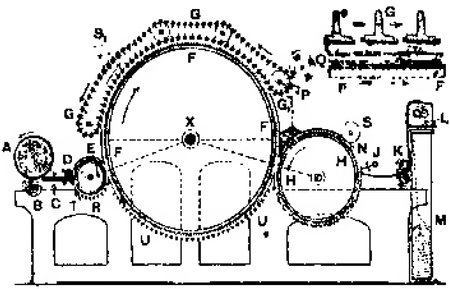


FIG. 58.—SECTION THROUGH CARDING MACHINE.

thorough opening and cleaning process is still necessary. This process is called carding, and the machine used is called a card. An illustration of a card is given in Fig. 58 in section.

The description may be brief, as the opening elements have already been described. The lap from the scutcher is placed behind the card at *A*, and is taken forward by the feed roller *D* along a dish plate *C*. This dish plate extends under the feed roller and is shaped so that as the cotton passes between the roller and plate it emerges

over the plate into the path of a rapidly revolving cylinder *E* (taker-in) covered with saw teeth. These saw teeth pass through the fed sheet of cotton and detach the fibres singly or in small tufts. These fibres are carried round, and as they reach the opposite side a large cylinder *F*, covered with a multitude of fine wire points and running at a high surface speed, strips the fibres from the saw teeth and carries them upwards until they are met by another surface of fine pointed wires

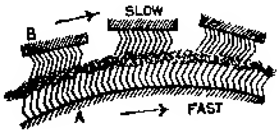


FIG. 59.—DIAGRAM REPRESENTING FLATS AND CARD CYLINDER.

which are set very close to the cylinder wires, so close in some cases as $\frac{7}{1000}$th of an inch. This upper series of wire points covers the cylinder over a third of the circumference, and it is built up of a series of iron strips called *flats*, as in Fig. 59, each covered with wire points as is also shown in the upper right-hand of Fig. 58. All the flats are carried at each end by a chain, so they form a flexible chain drive, and are supported by an adjustable surface called a flexible bend. They are constantly moving at a slow rate over the cylinder surface in the same direction as the cylinder. The cotton passes between these two wire-pointed surfaces, and in doing so it is opened thoroughly into its individual fibres.

After passing the flats, the fibres are met by another cylinder called the doffer (*see* Fig. 60) covered with wire points set very close together and very near to the cylinder. Here the fibres are deposited on the doffer, which slowly carries them away from the cylinder. This has the effect

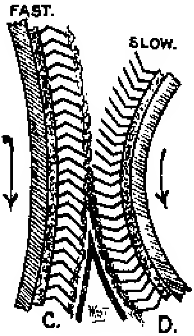


FIG. 60.—DOFFER REMOVING FIBRES FROM CARD CYLINDER.

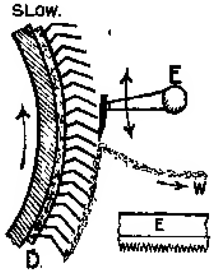


FIG 61.—COMB STRIPPING FROM DOFFER.

of condensing the fibres on the doffer owing to the difference between the surface speeds of cylinder and doffer. As the doffer brings the fibres to the front they are stripped off its surface by a rapidly reciprocating comb, as shown in Fig. 61. The cotton comes away in the form of a thin web. This web is sufficiently thin and fragile to be gathered together and passed through a funnel opening, as in Fig. 62, to rollers *R*, and from here it is passed upward as a rope or sliver to the coiler which winds it into the can *M*, in a

manner already described. Various details of this machine have been given in the mechanical elements (Chapter III) so it is unnecessary to repeat them here. It may be added that a considerable quantity of dirt, short fibres, neps and impurities are removed by the taker-in, by the flats, and by the cylinder. The waste, as it is

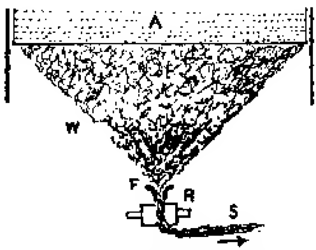


FIG. 62.—FUNNEL AND ROLLERS FORMING WEB INTO SLIVER

termed, becomes embedded in the cylinder wires, and has to be brushed out frequently; the doffer also has fibres and dirt pressed into its wires, so these require cleaning. The flats do not retain much dirt or fibres within the depth of their wires, so that they are readily cleaned of their surface waste by a stripping comb which is in constant operation as the flats travel round. This is shown at *P* in Fig. 58.

It will have been noted that the card has been the means of doing several important things, apart from its opening and cleaning functions. It has produced two new ordered conditions of

the cotton, viz., a web and a rope-form called a sliver. It has also reduced the thick blanket fleece in the form of a lap, to a loose thick rope form to the extent that 1 yard of the lap has become, say, 100 yards of rope or sliver. This attenuation or drawing of the cotton is the greatest that occurs in any single machine in a cotton mill, and it is effected by the excess surface speed of one organ over the one that precedes it.

CHAPTER VII

DRAWING FRAMES

THE essential features of a draw frame are shown in Fig. 63. The sliver cans that have been filled up at the card are placed behind the machine, and the slivers from each of, say, six cans are led side by side through the guide plate *A* over spoons *B*, through a pair of rollers *C* and *D* and on to the four pairs of drawing rollers *F*, *G*, *H*, and *J*. From the front roller *J*, the six drawn-out slivers are combined into one, and are passed down the funnel guide *L* to the calender rollers and thence into the coiler.

Three important operations are performed during the passage of the cotton through this machine: (1) The four lines of rollers are drawing rollers, hence the name of the machine. The surface speed of *J* is usually six times the surface speed of *F*, if six slivers are passed through. This means that the resulting sliver from a draw frame differs little in size from one of the card

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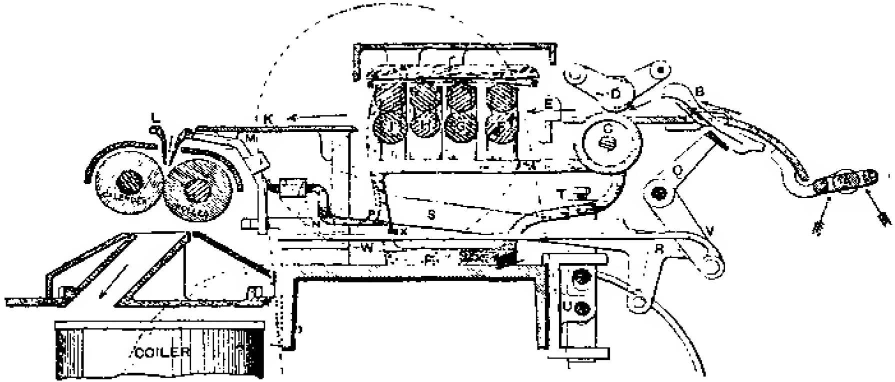

Fig. 63.—Section of Draw Frame.

slivers fed to it. This is the *drawing* action of the machine. (2) As the fibres are drawn apart over each other by the drawing action they are straightened and laid more parallel to each other, so that "drawing" results in *parallelization* of the fibres. (3) There is also the *doubling* process whereby six slivers are combined into one, after each has been drawn out to six times its original length and one-sixth its original area. The resulting single sliver is of the same size as each of the original slivers, but is much more regular and uniform.

Slivers are delicate pieces of cotton and are easily broken. If a sliver breaks, it must be pieced together at once, otherwise the machine will only take five slivers through, and consequently there will be an irregularity in the final sliver. The operative may easily overlook breakages, so automatic stop motions are applied which stop the machine immediately an end breaks. The use of the spoon levers is for this purpose. Each sliver normally passes over a spoon and depresses the spoon end, but when a sliver breaks or a can runs empty the tension or pressure exerted by the sliver is removed, the spoon end rises, and its other arm falls into the path of a reciprocating lever and holds it fast. The arm *S* which operates the reciprocating lever continues to vibrate, but as it cannot move the part held by the spoon it must lift, and in doing so knocks off a catch which holds the strap fork. A somewhat similar stop arrangement is provided at the front of the machine connected to the funnel *L*, through which the sliver passes to the coiler; a breakage of the sliver here will also stop the machine.

The process of drawing may be repeated two, three, or four times on other similar machines, the purpose being to parallelize the fibre and attain regularity by repeated doublings. The drawing action in the draw frame is used solely to parallelize the fibres.

CHAPTER VIII

COMBERS

In the processes already described the cotton has been opened and cleaned by various machines; it has been doubled repeatedly in different ways, and the fibres have been subjected to a very considerable drawing action in order to attain some degree of parallelization. This may be sufficient for some purposes, but for others, all this repeated manipulation has left the cotton in an unsatisfactory condition. The cotton must still be subjected to a further combing process to eliminate short and curly fibres and to arrange the fibres in a far more nearly parallel condition. The machine for this purpose is the comber. Up to this stage the cotton is in the form of a sliver. The machine about to be used requires the cotton to be in the form of a lap, so we must combine a number of slivers side by side and roll them into a lap. This operation is performed by a *Derby doubler* or *sliver lap machine*. A number of slivers side by side are not suggestive of evenness, so these laps are passed through drawing rollers and made into very thin sheets. Several of these thin sheets

are superimposed to form a thick sheet, which is then rolled up into a lap about 10 ins. wide. This operation is done by a *ribbon lap machine*, and it will be noted that doubling and drawing, and

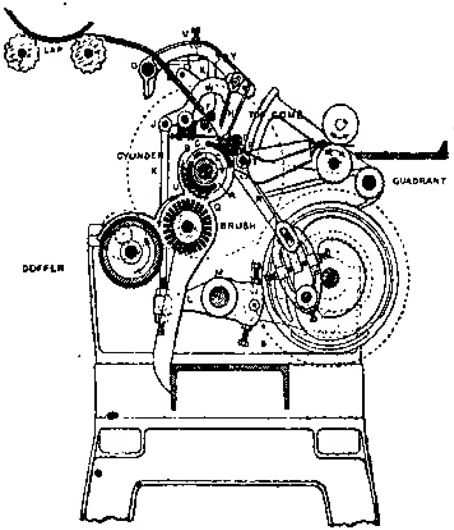

FIG. 64.—COMBING MACHINE

consequently parallelizing have been extensively employed.

A combing machine is illustrated in Fig. 64. The action of the machine is intermittent. The sheet of cotton from the lap is fed forward a short

length at a time, a pair of nippers close on the sheet and, as they hold it, combs on a revolving cylinder pass through the projecting cotton and comb out all loose fibres. When the needles have passed, a fluted portion of the cylinder follows, and a roller is lowered on to this fluted portion. At the same time the nippers open so that the movement of the cylinder and roller draws out a certain portion of the combed cotton, which is carried forward between the roller and pieced on to the end of the previously combed portion which is turned back for this purpose. That portion of cotton which has been combed and detached from the rest of the fleece may drag with it short fibres, so the cotton, on being taken forward by the detaching rollers, is dragged through a comb which is lowered into its path at the correct moment. This comb (top comb is the term used) frees the tail end of the combed cotton from loose and short fibres. The various intermittent actions are controlled by cams and special gearing. Very accurate adjustments are necessary for any given length of fibre, and the timing of the commencement and finishing of each action must be done carefully. Considerable waste is taken out and is collected to be used for lower qualities of yarns. The combed product of the machine is in the form of a web of a thin and silky appearance. This web of cotton is gathered into a sliver by passing it through a funnel and, as the machine produces several of these slivers, they are all passed together through drawing rollers and drawn out into a single sliver which is coiled into a can.

CHAPTER IX

FLYER AND BOBBIN FRAMES

THE essential feature of these machines is a drawing process, i.e. to reduce the thick sliver down to a very thin condition termed a roving. When the sliver is reduced in thickness and correspondingly lengthened, it cannot conveniently be coiled in a can, so it must be wound on a bobbin, and in order that this may be done it must be given a slight amount of twist to strengthen it. The twisting of the roving and winding it on a bobbin necessitate several mechanical devices, which rather overshadow the real purpose of the machine.

A general view of flyer frames is given in Fig. 65. Cans full of sliver are placed at the back of the machine, and the slivers are led from these cans to the rollers through which they pass, and by which they are drawn out to, say, one-sixth of their original size. From the rollers this much thinner *roving* is led to the top of the flyer, and passed down one of the arms of the latter which is made hollow or tubular. After a twist or two round a swivel lever or presser at the lower end of the flyer, the roving passes to the bobbin on which it is wound.

The cotton is now in another form of an ordered condition, for it is wound on a bobbin, and these bobbins can be carried about and freely handled. The amount of drawing or *draft* effected on the sliver has not, as a rule, made the resulting roving fine enough for spinning purposes, so the operation must be repeated on another or even on two or

three other machines of exactly the same type. Instead of sliver cans, however, we now have

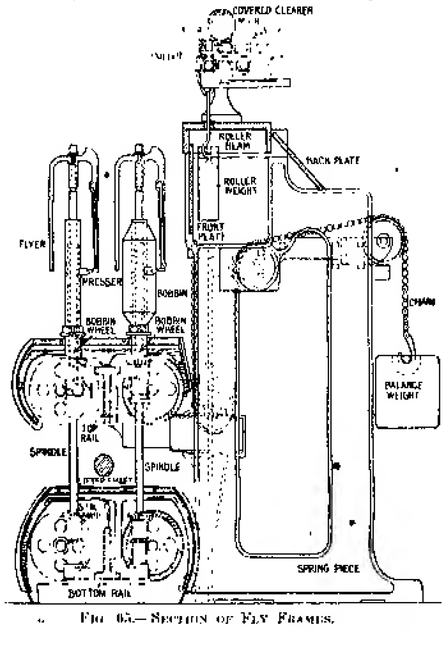

FIG. 65.—SECTION OF FLY FRAMES.

bobbins, and these are arranged on a creel in tiers, as shown in Fig. 66.

As the roving is reduced in size in each machine the bobbins are smaller, and a somewhat smaller

machine is used. Special names have been given to the series of fly frames such as 1st, slubber; 2nd, intermediate fly frame; 3rd, roving frame; 4th, jack frame, or fine roving frame. For fly frame the term *speeder* is frequently used in some districts.

A conventional view of the gearing of a fly frame will enable one to trace out the various movements of the machine. In the first place it must be observed that the flyer always revolves at a constant speed and the rollers deliver roving at a uniform rate. In order to wind on this roving, the bobbins must revolve a little faster than the spindle, and as the bobbin gets larger in diameter its speed is reduced gradually, but never to the spindle speed. It will be seen from this that the bobbin is always leading and drawing the roving on to itself.

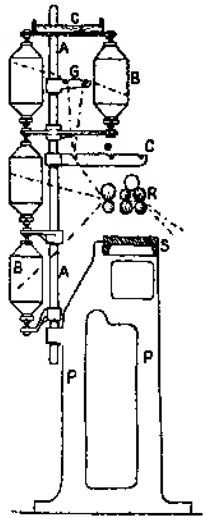

FIG. 68.—BOBBIN AND FLY FRAME WITH CREEL.

The gradual reduction of the speed of the bobbin, as it is built up, is effected by the cone-drums in Fig. 67. The strap connecting the cone-drums is moved along from the large diameter of the top cone-drum to the small diameter. As the top

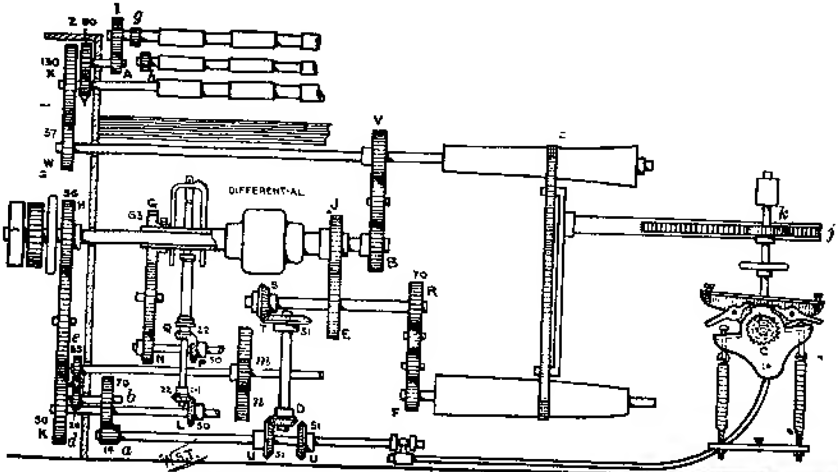

FIG. 67.—GEARING OF FLYER AND BOBBIN FRAME.

cone-drum is the driver, this change of the strap will cause a reduction in speed of the bobbins which are driven from the bottom cone-drum. The cone-drums are curved in outline. The necessity for this shape arises because a layer of yarn on the empty bobbin increases the diameter by a certain proportion, but the same layer put on a full bobbin increases the diameter by a far less proportion. A familiar example might be used by saying that a penny added to a penny doubles it, but a penny added to twelve pennies increases the amount by only one-twelfth of the original amount. Since the proportionate increase in the diameter varies for each layer added, the cone drums are given a curved form to meet this condition.

The spindles revolve in stationary footsteps, so the bobbins are raised and lowered by means of the bobbin rail on which they rest. The movement of the bobbin rail is effected by gearing, and the to-and-fro movement by putting the bevel wheels *U* (Fig. 67) alternately in gear with the bevel wheel *D*. This reversing gear is operated by a building motion at *C*, which has a trip action. The catches shown in Fig. 67 are tripped earlier after each layer of coils by means of a lever rack, the fulcrum of which is altered at each lift. This causes the reversal of the bobbin rail to be earlier each lift, and consequently the lift is shorter, and a conical-ended bobbin is obtained.

In conjunction with Fig. 67, a set of diagrams of the gearing is given in Figs. 68-71. These show how each element is driven from the driving shaft of the machine.

CHAPTER X

SELF ACTING MULES

It will have been seen that the fly frame is quite capable of twisting the roving, and the reader may reasonably conclude that the roving could be spun into yarn on this kind of frame. As a matter of fact, this method was formerly used extensively, but it is now confined to low numbers in cotton spinning, though in flax and jute most of the yarn is spun on the flyer system. The final twisting, after the roving has been reduced or drawn down to a suitably small size, requires a large number of twists, and this naturally means that the flyer must revolve very rapidly. Centrifugal force causes the strongest metal arms of a flyer to spread out when the flyer revolves at a high speed, so for this and other reasons this method has been abandoned. Inventive minds set to work to develop a method of spinning yarn without the use of a flyer, and the self acting mule was the ultimate outcome of these efforts. Its essential feature is to twist a certain length of the roving and, after this operation is completed, to wind the twisted length on to a spindle. This is probably the most ancient method of spinning but, in order to apply it to a productive machine, the intermittent operation necessitates a peculiar type of construction and an ingenious set of mechanical movements to perform the various actions.

Owing to the fact that the fly frames are now not used for more than a limited drawing effect,

the mule is supplied with drawing rollers so that one of its features is to attenuate the roving. A simple diagram will suffice for a brief description of the main functions of the machine. In Fig. 72 the bobbins from the fly frame are placed in the creel, and from here the rovings are led to the

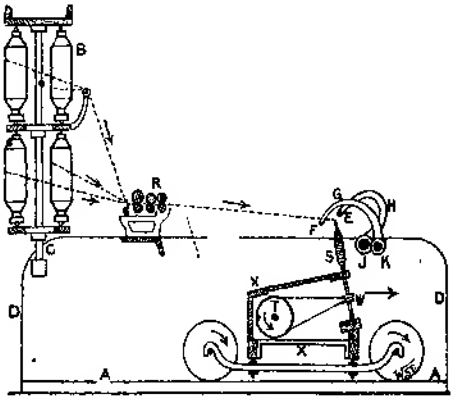

FIG. 72.—SELF ACTING MULE.

rollers *R* where they are drawn out into a much finer roving. From the front roller the roving is fixed to the spindle *S*. These spindles are carried by a movable structure called a carriage *X*, which can travel to and fro along the iron rails *A* fastened to the floor. The carriage may contain over 1,000 spindles, spaced, say, 1¼ ins. apart. Motion is imparted to the tin drum *T* which, by means of a band, drives the spindle at a high velocity, say, 10,000 revs. per min. The spindle being perfectly

balanced and having no arms or other projections, can be driven at this high speed. As already explained the revolutions of the spindle will put into the roving a corresponding number of twists. Simultaneously with the turning of the spindles, the rollers *R* begin to deliver the roving, and the carriage commences to move away from the rollers. These three movements continue until the carriage has moved through a distance of, say, 64 ins., measured from its starting point near to the rollers. By the time it has finished this outward run the spindles will have revolved, say, 2,000 times, so that the 64 ins. stretched between the rollers *R* and the spindles will contain 2,000 twists or about 31 twists in every inch of its length, a degree of twisting that binds all the fibres together, and gives strength to the yarn. Automatically the carriage now begins its return journey back to the rollers, and during this return journey the twisted or spun yarn is wound on to the spindles through the medium of two wires *F* and *E* operated through the arms or faller sickles *G* and *H* fastened on the faller rods *J* and *K*, by a special builder or shaper to be hereafter described. The two movements of the carriage are alternately continuous as long as the machine is in action.

With the above main facts before us we can now enter into fuller detail, and to assist in this direction the four following diagrams have been prepared. Fig. 73 represents the spindles at their nearest position to the front rollers *R*, and the carriage is just commencing to make its outward run. The rollers are delivering roving, spinning is taking place, and the yarn is free of the two faller wires *E* and *F*.

These conditions exist until the carriage has travelled, say, 64 ins., this distance being termed

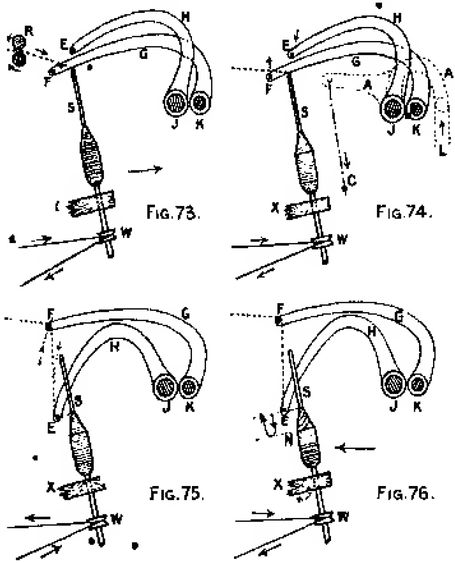

Fig. 73 Carriage Commencing Outward Run. Yarn being Spun

Fig. 74. Carriage Stopped at End of Stretch.

Fig. 75. Backing-off Completed.

Fig. 76. Carriage Commencing Inward Run. Yarn being Wound

the *stretch*. The carriage then comes to a stop, and for the fraction of a second we have the position

shown in diagram Fig. 74, which apparently is the same as Fig. 73. No arrows, however, are shown, indicating that for this moment, no motion is taking place as regards the carriage and spindles. Another motion, however, comes into action whereby a chain C is wound on a drum, and pulls down the lever A keyed on the faller shaft J. This lowers the faller wire E, and at the same time the faller wire F rises. Simultaneously with these movements of the faller wires, the spindles are reversed in direction so that we now have the conditions represented by Fig. 75. The action just described is termed backing-off. It will be observed in Fig. 73 that whilst spinning there must be a series of coils of yarn on the spindle from the cop to the spindle point. In Fig. 75 these coils have disappeared, due to turning the spindles backwards, which naturally unwinds the coils. In order to take up the slack which would otherwise be formed by this unwinding action, the faller wire E moves downwards as the yarn is unwound by the spindle, and the faller wire F moves upwards at a rate to keep the yarn in tension. The wire F is kept in the position, shown by the tensions of, say, 1,000 strands of yarn, balancing a series of weights tending to move the faller wire still higher.

Backing-off having been completed in the course of 2 to 3 seconds, changes occur in the driving, and we have the conditions as shown in Fig. 76. The carriage commences to move in towards the rollers. The spindles revolve in the same direction as when spinning, but at a very slow rate and the yarn is thus wound on the spindles. Backing-off has only lowered the faller wire E to the upper

end of the cop, or, as it is called, the nose of the cop. The wire *E* must now guide the yarn on to the cop, so that we get a methodical form on our spindle for further handling; the wire is, therefore, moved downwards by another piece of mechanism termed a *Shaper*, which operating through a link *L* (*see* Fig. 74) moves *E* down to *N* at a quick rate, thus producing widely spaced coils on the cop, and then slowly upwards again, giving a series of closely wound coils on the cop surface.

Mechanism of the Self Acting Mule. Mechanism is provided for the following series of operations: (1) To drive the carriage on its outward run. (2) To revolve the rollers. (3) To drive the spindles at a high rate of revolution. (4) To stop the carriage. (5) To back-off. (6) To connect the faller rod *I* with the shaper. (7) To drive the carriage on its inward run, and to revolve the spindles at a suitable speed to wind on the yarn in the form of a cop given to it by the shaper.

Movement of Carriage during Spinning. The carriage is moved on its outward run as indicated diagrammatically in Fig. 77. A shaft called the *back shaft* goes the full length of the mule. On it are placed helically grooved drums *B*, round which the bands are wound. These bands are connected to bowls *A* on the carriage. The back shaft is driven from the front roller *R* by gearing as shown. A catch box on the back shaft is used to disconnect the back shaft from the front roller when the carriage has been drawn out. It will be seen that the drum or back shaft scroll *B* will pull the carriage out, and that another band unwinds from the other side of the scroll. This acts as a check, and also assists in returning the

back shaft when the carriage makes its inward run. Since the carriage is entirely under the control of the front roller during spinning, the movement of the carriage corresponds to the surface speed of the front roller. It frequently happens that it is desirable to stretch or draw the yarn as spinning takes place. This is done by moving

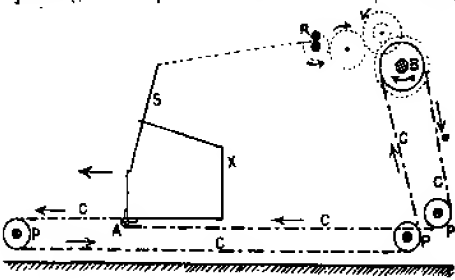

FIG. 77.—MOVEMENT OF SELF ACTING MULE CARRIAGE DURING SPINNING.

the carriage at a rate slightly in excess of the surface speed of the front roller. This extra movement is called the *gain*.

Movement of the Carriage during Winding. This is the inward run of the carriage, and is almost invariably designated *drawing-up*. Fig. 78 will convey an idea of the usual method. A shaft D is driven by a rope pulley from the countershaft, and through bevels it drives the vertical shaft V. On this shaft is placed a conical friction clutch F, which when in gear will drive the shaft on which the scrolls S are keyed. These scrolls have spiral grooves ranging from a small diameter to a large diameter, and back to a small diameter. Ropes

are fixed to the small diameter of the scrolls, and one rope, B, is fastened to the carriage at T. The revolution of the scroll dotted in Fig. 78 draws the carriage inwards. The other scroll unwinds its rope, and as this rope C is attached to

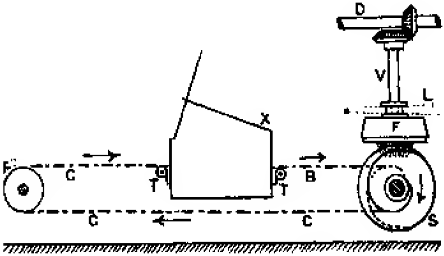

FIG. 78.—MOVEMENT OF SELF ACTING MULE CARRIAGE DURING WINDING

the carriage, the two scrolls keep the carriage under control. The scroll with the rope or band C is usually called the check scroll, as it effectually prevents the momentum of the carriage from overrunning the pull of the band B, from the drawing-up scrolls.

The use of a scroll for drawing up is in order to start the heavy mass of the carriage at a slow rate, and gradually to increase the speed until the middle of the stretch; from here the speed will decrease gradually until the band is on the smallest diameter as the carriage stops. An arrangement of levers and links is used to put the friction clutch F in and out of gear, these levers being operated by the carriage as it gets near to its extreme positions.

In many cases the shaft D is fitted with a fast and loose pulley; when this is done, the friction clutch is not necessary, the starting and stopping of the scroll shaft being performed by moving the strap on to the fast or the loose pulley by a strap fork acted upon by some projection on the carriage.

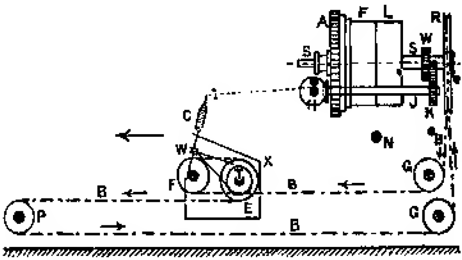

FIG. 79.—SPINDLE DRIVING DURING SPINNING.

Spindle Driving during Spinning. The spindles revolve at a very high speed during the twisting process. The carriage, containing the spindles, is moving outwards, so a strong rope or band is used as shown in Fig. 79. The main shaft of the mule is S, called the rim shaft. When the belt is on the fast pulley F, the shaft is driven and also the grooved rim pulley R fastened on its end. An endless band kept taut by the guide pulleys G is threaded round the pulley R, over guide pulleys G, P, and F, and over the pulley on the tin roller E. The large rim pulley R runs at a high speed, and the tin roller revolves faster than this since E is usually much smaller than R. The tin roller drives the spindle through a small band on to the

warve W. Two and three grooved pulleys are used so that all the guide pulleys have to be similarly grooved. The movement of the carriage, it will be noted, does not interfere with the driving of the spindles. A form of free wheel arrangement is provided on the tin roller shaft whereby the tin roller can be reversed for backing-off. Incidentally, the diagram Fig. 79 shows how the front roller is driven.

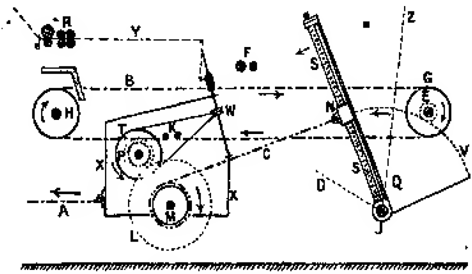

FIG. 80.—SPINDLE DRIVING DURING WINDING.

Driving the Spindles during Winding. An indirect method is used to revolve the spindles for winding on the twisted yarn that lies between the spindles and rollers when the carriage has completed its outward run. Referring to Fig. 80, the carriage X is drawn up by the scroll band A as already explained. A rope B is fixed to the carriage at K, and passes over a loose guide bowl H, back to the front of the machine, where it is wound several times round a grooved drum G keyed on a shaft, and then passes to the carriage. As the carriage moves to and fro in its cycle of

operations, the band B causes the drum G and its shaft to revolve. On the shaft of G is keyed a small wheel which gears into a toothed quadrant F attached to a long arm centred at J, and carrying a screw S on which a nut N is threaded. To the nut N is hooked a chain C, which passes round a drum M on the carriage. A wheel L on this drum gears with a wheel P on the tin roller shaft. The tin roller carries the small bands driving the spindles.

As the carriage makes its inward run through the pull of the scroll band A, the small wheel E turns the quadrant and arm in the same direction as that in which the carriage is moving. The nut N, however, moves more slowly than the carriage, and as a consequence the drum M must yield by being pulled round by the chain C. This motion of the drum M is then transferred to the spindles. At the commencement of building a cop the nut N is low down near to the centre J, and as in this position it can move only through a very short distance, the chain turns the spindles, say, 80 revolutions to wind on the 64 ins. of stretch. As the cop bottom builds up, the nut is raised up the screw, and may reach anywhere from half way to the top, this depending upon the size of the cop bottom. When at its highest position, the cop has a conical surface with the large diameter at the shoulder and tapering to the diameter of the bare spindle so that this surface will require only about 25 revolutions of the spindle to wind on the 64 ins. of yarn. The angular movement of the quadrant arm will be about that shown by the angle, $N J D$. It may be added that the wheel P is not fixed on the tin roller shaft, but acts by

means of a click pawl on a ratchet wheel keyed on the shaft. This permits the tin drum to be driven for spinning without interfering with the drum M. A cord passed round the drum M and led to a hanging weight at the back of the machine raises the weight during the run-in of the carriage, so that when the carriage makes its outward run the weight falls and rewinds the chain C on the drum M.

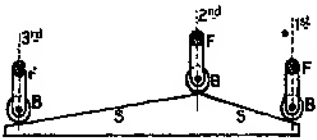

FIG. 81. ILLUSTRATING RISE AND FALL OF BOWL AND FORK PRODUCED BY INCLINED SURFACE

The Shaper. We have seen how the spindles are revolved in order to wind the yarn on as it passes under the faller wire. This wire, however, must be moved so that the yarn is wound over the surface of the cop, and it must also be moved so as to guide the yarn on to new surfaces as the cop builds or lengthens. The function of moving the wire or copping faller wire as it is called, is carried out by the shaper. A few preliminary words will make clear the method. Suppose that a bowl B (Fig. 81) carried by a fork F, is moved along a fixed incline surface S, the bowl and fork being kept vertical by a guide bracket. The effect of passing over the incline is that the bowl and fork are raised when passing from the 1st to the 2nd position, and lowered as they pass from the 2nd to the 3rd position. On returning from the 3rd to the 1st position, the bowl will

rise and then fall. It will be seen that we can make the incline *S* to raise and lower the bowl and fork in any degree required. In the mule we have this arrangement, and the guide which carries the fork and bowl is part of the middle component of the carriage or carriage square as it is termed.

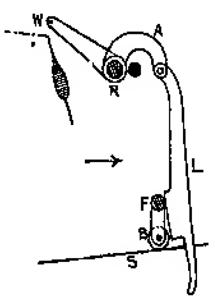

FIG. 82.—BOWL AND FORK INOPERATIVE DURING SPINNING.

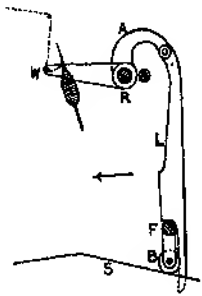

FIG. 83.—BOWL AND FORK IN ACTION DURING WINDING.

The bowl, being always on the incline, will rise and fall both when the carriage is running out and running in, but the action of the bowl must be inoperative when the carriage is running out, and only effective when winding is taking place as the carriage runs in. The diagram in Fig. 82, will make this clear. The winding faller *R* is coupled by the arm *A*, to a freely hanging link or leg *L*. As the carriage runs out and spinning is in action the faller wire *W* is out of the way and

stationary, and the leg L is made so that it simply rests against the fork F as shown.

Under these conditions the rise and fall of the bowl and fork have no effect on the faller wire. When backing off takes place, the faller wire W is pulled down, and this has the effect of pulling up the leg L. This leg is cut away as shown, so that when it is pulled up it drops over the top of the fork (a spring aids it to do this) and rests in the position shown in Fig. 83. The carriage

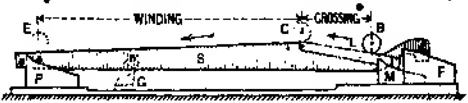

FIG. 84. ILLUSTRATING ACTUAL SHAPER USED ON THE SELF ACTING MULE.

now commences its inward run, and all the parts shown except the incline S partake of this movement. The bowl B and fork F rise and, in doing so, they lift the leg L and depress the copping faller wire W. The faller leg L in this position is said to be locked because, for the time being, it has become part of the fork and bowl. A projection is provided on the leg and, as the carriage approaches the rollers, this extension is brought against a stop so that it cannot continue its movement. The carriage, however, moves a little further so that the fork and bowl are moved from underneath the recessed part of the leg, and the leg L falls down free from control, and in doing so raises the winding faller wire W up to the position it occupies when spinning is taking place. Thereafter, the above cycle of events is repeated.

Fig. 84 will convey a definite idea of the actual

shaper used on the mule. The inclined surfaces on which the bowl travels are marked *S* and *L*. The long incline *S* is a strong bar with supporting pins at each end. These pins rest on specially shaped plates *F* and *P*. A short incline *L* is swivelled at *C*, and its other end is supported by a middle plate *M*. The three plates, *F*, *M* and *P*, are mounted in slides, and are all connected together when set. A guide bracket *G* prevents any horizontal movement of the shaper *S*. As the bowl travels from *B* to *C* the faller wire is lowered from the nose to the shoulder of the cop and, as *L* is short, the yarn is wound on in coarse spirals. From *C* to *E* the bowl is lowered so that the faller wire rises and, as *S* is a long slope, the wire rises slowly and guides the yarn in more closely arranged spirals. The cop bottom, starting as it does on a bare spindle, or practically so, and finishing with a prominent conical surface higher up the spindle, necessitates an alteration of the shaper in order to raise the starting and finishing points of each layer, and to lengthen the chase or distance moved by the wire after each layer has been wound on. These alterations are effected by the special shapes given to the plates *F*, *M*, *P*. After the cop bottom is made, which is the foundation of the cop, the rest of the cop is almost uniform. It is simply lengthened by practically uniform additions of conical layers. The parts of the plates that do this are the straight inclined portions. Enlarged views of the plates are shown in Fig. 85, where the plates are superimposed so that they may easily be compared.

The front plate *F*, Fig. 84, carries a nut which works on a screw carried in fixed bearings. On

the end of the screw is a ratchet wheel and pawl. As the carriage comes out, a finger operates the pawl and turns the screw slightly so that all three plates move backwards, and so lower the shaper

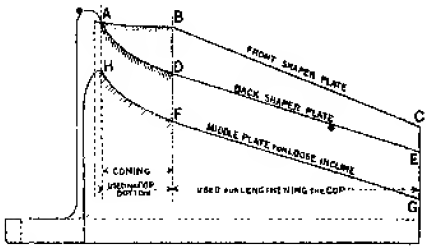

FIG. 85. PROFILES OF FRONT AND BACK SHAPER PLATES AND OF MIDDLE PLATE SUPERIMPOSED FOR COMPARISON.

bodily. The differences in the shapes of the plates lower the ends and middle in different degrees to bring about the raising of the nose and the shoulder, and to lengthen the chase or length between the nose and shoulder.

CHAPTER XI

RING SPINNING MACHINE

The ring spinning frame is a continuous action one, i.e. spinning and winding are going on at the same time. The bobbins from the fly frames are placed in a creel, and the rovings are led from here through a series of drawing rollers. From these rollers the roving passes through a guide and

down to a bent piece of wire which is free to move, around a steel ring on which it is hooked. The yarn is threaded through the traveller wire and on to the spindle bobbin. Through the centre of the steel ring is the spindle in a vertical position. The guide is placed directly over the centre of the spindle, and some short distance above it. The spindle is provided with a warve, and is driven by a band from a tin roller. The machine is two-sided, i.e. there is a row of bobbins, rollers, spindles, rings, tin roller, etc., on each side of the machine, though the whole machine is driven from one shaft, and one shaper or building motion actuates both sides. The spindles are spaced apart, the space being dependent upon the size of bobbin made. Fig. 86 will give an idea of the general disposition of the parts.

The detail of the rollers, spindle, etc., are given in Fig. 87. There are the usual three lines of rollers for drafting purposes. These rollers are disposed in an inclined position in order that the twist can get as near as possible to the grip of the front pair. The tipping up of the rollers really brings the top roller further over the bottom roller, and so moves the grip forward.

The sketch in Fig. 88 shows how the ring and traveller are carried. The ring *R* is of the hardest steel, perfect in shape, and highly polished on the ledge where the traveller *T* moves. The rings *R* are mounted in plates *P*, and secured by set screws. The ring plates are in turn mounted on brackets *A* fastened to the top of vertical rods *S*. These rods or pokers are guided by passing through bushes *B* fixed on the spindle rail *C*. The builder motion actuates these pokers, and so raises and

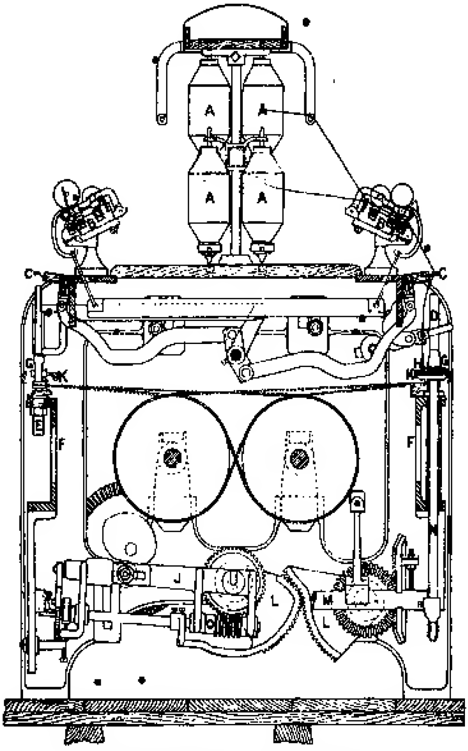

FIG. 86.—SECTION THROUGH RING SPINNING FRAME, LOOKING TOWARDS THE HEADSTOCK.

A. Creel.
B. Drawing rollers.
C. Thread guide.
D. Bobbin.
E. Oil cup of spindle.
F. Spindle rail.
G. Spindle.
H. Traveller.
J. Builder lever.
K. Ring rail.
L. Shaper or builder segments.
M. Framing.
N. Ring rail poker.

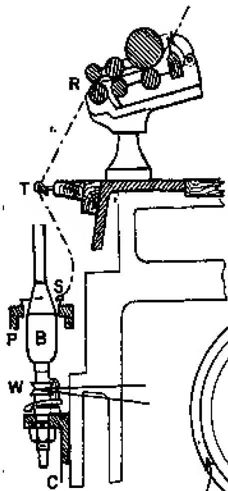

FIG. 87.

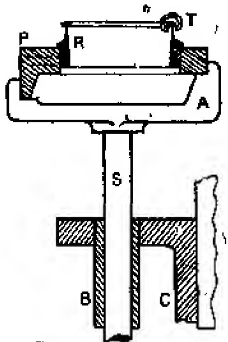

FIG 88.

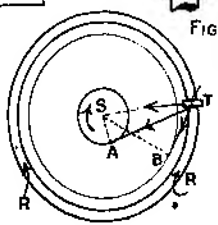

FIG. 89

FIG. 87.—DETAIL OF ROLLER, SPINDLES, ETC., IN RING SPINNING FRAME.

FIG. 88.—DETAIL OF RING AND TRAVELLER IN RING SPINNING FRAME.

FIG. 89.—ILLUSTRATING PASSAGE OF THE YARN THROUGH THE TRAVELLER, ON TO THE BOBBIN.

lowers the ring rail in building the bobbin. The traveller *T* acts as the guide for the yarn as the bobbin winds it on, as well as putting the twists into the yarn.

Fig. 89 is a diagram to illustrate the passage of the yarn through the traveller and on to the bobbin. The two extreme diameters of the bobbin are shown, the bare bobbin at *S* and the full diameter at *B*. When the bare bobbin *S* revolves, it exerts a pull on the yarn along *A*, *T*. With the pull in this direction it is difficult for the yarn to move the traveller *T*, hence there is a high tension in the yarn when winding on the small diameter. When the large diameter is winding, the pull exerted is along *B*, *T*, and this pull readily moves the traveller *T* around the ring *R*; hence a much less tension is now placed on the yarn.

There is always a length of yarn between the traveller and the thread guide, and the high speed of rotation of the yarn causes the latter to fly outwards this action being termed *ballooning*. This ballooning would cause adjacent yarn to lash into each other unless spindles were spaced wide apart hence plates or separators are placed between adjacent spindles to enable the latter to be set closer together than would otherwise be possible.

Due to the varying tension on the yarn—from a high tension on the small diameter of the bobbin to a lower tension on the larger diameter—the main ballooning effect is always produced when winding on the large diameter, and in most cases very little ballooning is to be noted when winding on the small diameter, the high tension then preventing it.

As the traveller moves round the ring at almost the same speed as the spindle, the traveller exerts a pressure against the ring due to centrifugal force. This pressure is a necessary one, and in fact, one might say the main one to regulate the winding; it acts as a retarding effect to the pull of the yarn. If the centrifugal force on the traveller is too small the winding is slack, whilst if the centrifugal force is too great very tight winding is produced, and possibly constant breakages of the yarn. The weight of the traveller is, therefore, an important factor in winding at the right tension. It is possible, by using heavier travellers, to neutralize the ballooning, but this simply means that an extra degree of tension is thrown on the yarn when winding on the small diameter of the bobbin.

Even from this brief statement it may be concluded that if the correct traveller, the right diameter of ring and empty bobbin are used, and the winding is just right with a given speed, then it will be possible gradually to increase the speed of the spindle to a maximum when winding on the largest diameter, for by this means one can produce a more uniform tension in the yarn throughout the lift. Both mechanical and electrical devices have been tried to obtain this effect, and increased productions are a natural result.

Building Motions. The building motion is a very simple affair. The essentials are given in Fig. 90. A worm G drives a worm wheel H. On the shaft of H is fixed a cam C. This cam bears against a bowl carried by a lever L, fulcrumed at F. The other end of L carries a bowl B, which

can be made to revolve by a worm W and worm wheel, this worm carrying a ratchet wheel and pawl R, P. As the cam C revolves it moves the

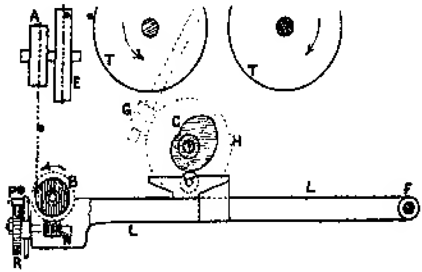

FIG. 90.—THE BUILDING MOTION OF A RING SPINNING FRAME.

lever L up and down, one of these movements being about three times quicker than the other, due to the shape of the cam. As the lever moves, a chain attached to the bowl B pulls round another bowl A on the shaft of which is a further bowl E. This bowl E is connected by chains and levers to the lifting pokers of the ring rail, mention of which has already been made. The movement of the lever L also brings the ratchet pawl in contact with a stop which moves the ratchet, and so turns the bowl, causing it to wind on a little of the chain. This causes the ring rail to start a little higher each lift, and so builds up the bobbin. The cam C, it may be added, is a perfectly plain cam, made to suit the conditions of the levers and chains employed.

Fig. 91 shows the connections of the builder to the ring rail. The chain *G* is attached to the bowl *E* of Fig. 90, and it is obvious from Fig. 91 how

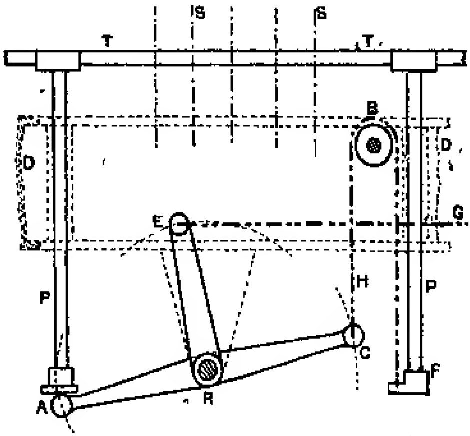

FIG. 91. ILLUSTRATING CONNECTION OF BUILDER TO RING RAIL.

the levers and chains raise the ring rail *T*. The ring rail falls by virtue of its own weight, aided by additional weights on the levers.

CHAPTER XII

PRACTICAL NOTES

Bales. When bales are delivered to the mill note their condition. Weigh each bale to check the gross weights, check the marks, and enter all

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particulars in the book. Break the bands and weigh them; take off all the wrappings and weigh them, entering both these items also in the bale book. If the weight of bands and of wrappings are excessive, claims can be made out for the difference.

Examine the cotton in the bale to see if up to sample. Also note if the cotton is damp. If there appears to be too much moisture present, test the cotton for the amount of moisture and, if excessive, a claim can be made out for the excess over the standard regain

Too much care cannot be taken in clearing from the cotton every particle of the wrapper. The fibres of the hemp, of which the wrappers are made, are a serious cause of bad ends and irregularities in the subsequent processes.

Hopper Bale Breaker. Set and knock off when a little above half full if fed automatically. If fed by hand never exceed the half full condition. Feed small pieces and set the evener roller or evener lattice so as to be effective in knocking off the lumpy cotton that may be taken up; at the same time do not set so close as to cause jambing and breakage of the spiked lattice and possibly other damage to the machine.

See that the fan is running full speed, and belt not slipping, so that the dust and fly are being taken away. Clean the machine frequently.

Hopper Feeder. Adjust the evener organ to suit the feed required. Set the swing door to operate when the hopper is a little above half full. See that the clutches or strap fork of the stop motion acts promptly when the lap end knocks off or when the swing board moves. If

the hopper is allowed to get too full or almost empty a very irregular feed will result. Do not use cotton that is not well opened by the bale breaker; rather pass the cotton through the bale breaker twice than feed lumpy material to the hopper feeder. Keep the machine clean and replace damaged laths at once. Do not allow the spiked lattice to run slack. See that the cotton in the hopper is fairly level in the width of the machine and not at higher level at one part than at another. Be careful to set the evener organ parallel to the spiked lattice.

Openers and Scutchers. Scrutinize the feed to the opener, if fed by lattice, to see that it is fairly uniform in thickness across the width, remembering that the pedal regulation has little effect on irregularities across the width of the feed. Try to obtain uniform laps on openers as well as scutchers, and do not think that the regularity of opener laps is of no importance. The use of two or more lines of scutchers is often a necessity, not to extract more waste but to obtain the regularizing effect of the doubling of the laps. Use a porcupine bladed beater on the scutcher in preference to the two or three bladed beater. When the strap has been set correctly for a given weight of lap, lock up the levers so that no unauthorized alteration can be made. Never set the beater too near to the feed roller. Carefully note how the cotton is deposited on the cages, and if the deposit is irregular examine the fan and the passages from it on each side of the machine. Exclude draughts, and see that the leather draught preventers are in good condition. Keep the lattices at a uniform tension. Do not imagine

that the regulator motion is sensitive enough to compensate for a lap running off and not being replaced soon enough. Use a turn over board when starting a new lap, and see that it is used to make a level start, and not a crumpled irregular one. See that the dampers inside the cages are set on the centre line of the cages or a little forward of the centre line, so that the fleece comes freely from between the cages. Inattention to this is a frequent cause of sticky laps. Keep the fan strap uniform in tension, also the lap end strap, and test the speeds frequently with a tachometer. Keep a record of the weights of all the laps made on the scutcher, and frequently weigh the opener laps. Frequently test yard or two-yard lengths of lap.

Cards. Start with a level edge to the lap and piece up carefully to a level edge of the preceding lap, remembering that 1 in. of fed lap will result in, say, 100 ins. of delivered sliver With a weighted feed roller see that both ends of the roller are equally weighted. Test the straightness of the feed roller. Set the taker-in to the cylinder, and then set the feed roller or dish feed and motor knives, unless the dish feed is carried on the taker-in bracket. If the taker-in is slightly out of truth and the bearer is slightly worn, setting should be done when the taker-in is at its nearest point to the cylinder. When setting the flats commence to adjust the flexible at the bracket that draws the flexible towards the centre of the cylinder. As a card is "set" when not working, all organs that revolve will occupy different positions when the machine is working. The two cylinder pedestals never wear alike, as one is subject to

the pull of the driving belt. A further point to observe is whether the pins on the flexible are bearing on the top of the adjustable bracket slots or on the bottom of the slots. If there is the least play in these slots, the settings will be altered when the machine begins to revolve. On starting up new wire clothing, the flexible is in a normal condition and the weight of the flats and the pull of the flat chain press the flexible pins down on the bottom surface of the slot in the bracket but, after some wear has taken place on the wire, the flexible will have been forced down into a strained position and the tension may be sufficient to counterbalance the weight of the flats and the pull of the chain drive and thus force the pins against the upper surface of the slot. These points require consideration in setting a card, and allowances must be made for them in the gauge used.

If a gauge shows any sign of wear, discontinue its use. Test a gauge, before using it, by a micrometer, and always have a standard set, for occasional checking purposes. Bent or distorted gauges should never be straightened and used again. Discard gauges used for setting wire surfaces after three years use, and get new ones. Never stamp names, etc., on thin sheet steel gauges, not even on parts that are not used for testing. It is a common occurrence for cards to be set up with old worn gauges by erectors and old carders and to give very good results, but when re-set by someone else to the same gauge numbers and with new gauges, quite different results are obtained.

Grinding and stripping are matters of organization. Keep a rough chart of the cards and number

them. Mark on the chart the time when each is ground. This will prevent carelessness: frequently cards are overlooked for long periods, but the check system will ensure that they are all done in turn. Often the stripping of cylinder and doffer is done carelessly, and faulty slivers are produced. Keep clean the draught preventer rollers, or clearer, on feed rollers. Keep the working surfaces of flat ends and the surface of flexible free from caked dirt. Adjust the speed of flats to the required amount of waste to be extracted, and adjust the front and back plates to suit this. Do not regulate the front plate for more or less flat waste strips. Do not have the web too tight between calender rollers and comb, nor the sliver too tight between calender rollers and coiler top; at both places irregularities are frequently produced. Piecings of sliver should be done carefully and not twisted up together. Keep machine free from fluff, also the funnel and clearers.

Draw Frames. Rollers to be set absolutely parallel to each other. No binding in the bearings. Top rollers absolutely parallel to bottom rollers. To those who consider the settings or spacing of the rollers to be very important, it will be essential to have the top rollers directly over the centres of the bottom rollers, as the nip of the rollers is the real setting point. Drafts between each pair of rollers to be well proportioned and not the same in each head. It is quite evident that the first head dealing with card sliver must be drafted differently from, say, the second and third heads which have a somewhat more regular and parallel set of fibres to act upon. This question is one

of judgment and reason, and cannot be decided by a rule, mathematical or otherwise. Keep the flutes well scoured. It is a great advantage to have bottom rollers case hardened all over. See that every bottom roller runs true. Never let a leather covered top roller get hollow. Use weights on the light side rather than on the heavy side. See that all wheels gear correctly. Cut gears are almost essential. Adjust the spoons and front trumpet so that they will act promptly. Some trumpets are used for all kinds of sliver and on finer sliver do not act when waste gets on it. Set the coiler so that the coils just clear the sides of the can. See that all cans revolve true. Use springs and plate in cans for fine cotton, and especially combed sliver. Have perfectly smooth surfaces on rollers and other surfaces over which the cotton passes. See that all collections of fluff and flat waste are removed whenever formed, and especially the under clearer's waste. Use a good varnish that dries smooth, and does not develop cracks. The use of a good varnish, of course, will reduce the flat waste.

Flyer and Bobbin Frames. The notes on the drawing frame rollers are applicable to these frames. The amount of twist put in the roving should be sufficient to ensure good winding and unwinding from the bobbins when put in the creel of the next machine. Too much twist may have some little effect on the drawing action of the subsequent machines, but its great disadvantage is loss in production. Too little twist results in stretched rovings of a very irregular character both on the bobbin being made and in the creel of the next machines. The creel of the mule

shows this stretching most prominently, as here the roving is fine and the stretching simply breaks the ends; but the same stretching occurs in the creels of all the passages of fly frames. Use good cone drum straps with butt piecings, or an endless belt or the patent belt. Start the set with the cone drum in the correct position for the diameter of the empty bobbin. Have a traverse guide for the roving which will travel almost the full length of the covered part of the roller. A variable traverse guide is best. Grooved and hollow top rollers are bad, so replace them before they reach that stage. Do not allow the tenters to interfere with the belt on the cone drum to humour the winding. See that flyers are balanced; that every part is perfectly smooth, that the legs and paddles or pressers are not distorted. Try to keep every spindle running and producing, and prevent carelessness by constant supervision. Do not permit any alterations of the tension by varying the turns of the roving round the presser; tenters frequently do this to bring a bobbin to normal size after an end has been down for a short time.

See that all spindles are running freely in the collars when the bobbin rail is at each end of the lift; that the rail is moving freely in the slides; that the long rack is not sticking; that no wheels are loose, and that all are correctly geared. Replace broken toothed wheels at once. Replace worn pigeons and catches. See that no faulty skewers and bobbins are in use; and that no footsteps in the creel are cracked or broken. Attend to the cleaning of all rollers, back, middle and front, as well as the traverse guides.

Bad ends must be avoided by careful piecing and by preventing waste or fluff from passing forward on the roving. Be particularly careful to see that the strike bevels are set correctly and act promptly.

Sliver Lap Machine. When this machine is used for making laps which go directly to the comber, a full width lap is made but, if the laps go to the ribbon lap machine, the laps must be made narrower in order to allow for the spreading out when drawing. The allowance is usually from 1 in. to $1\frac{1}{2}$ ins. See that each spoon is acting, and so adjusted as to act promptly when an end breaks. Make good level piecings. Have end plates and large fluted rollers perfectly smooth. Adjust the rack and gearing equally on both sides, and see that the friction block and pulley are effective and giving equal pressure at each end. Insist on care being used in starting a new lap to avoid a crumpled-up beginning. Keep clean.

Ribbon Lap (or Draw and Lap) Machine. The utmost care must be taken that all parts of the machine over which the cotton passes are perfectly polished. The plating of the curved plates and table should be watched carefully to see that the plating does not peel off and leave raw edges of metal. There is considerable friction between the cotton and plates, and variations are easily produced by this cause alone. Discard all planished steel plates. Test the lap frequently. Keep all bearings free from fluff, and protect the machine against strong draughts. Carefully adjust weights on calender rollers, and see that the brake is acting properly at all stages of the lift. A variable

brake is best. See that the locking of the spindle is done properly. Cut wheels are advisable. See that the spindle end plates and bobbin run perfectly true, and that the bobbin beds its full length on the fluted rollers. Keep the end plates free from contact with the framing, and guide the fleece on to the bobbin so that it does not get crunched up at each end. The top calender rollers should be driven positively. Stop motions for lap running out and for full lap, to be set carefully to act promptly.

Comber. Use well constructed gauges and let them be accurate. Test the cylinder for truth and discard all needles that have been oil-stoned down on their points in order to level them: a good magnifying glass will show the wide difference between good and badly set needles. Keep the top comb in perfect condition. Have all rollers, nippers, and combs perfectly parallel to the cylinder surface. Keep leather coverings in good condition. Do not allow hardened spots of dirt to remain on cylinder flutes. Examine nippers frequently, and see that the grip is always uniform. Screw up lock nuts carefully to ensure that no alteration in setting screws takes place through the vibration of the machine. Replace damaged half-lap at once. See that brush and doffer are acting properly and that all the waste is being carried away. Settings vary so much that no purpose would be served in giving timings and settings, but after re-setting, test carefully by hand driving and then find waste percentage. Perfect cleanliness is essential.

Bad ends in the Card room. A great variety of causes result in bad ends. The principal causes

and suggested remedies may be stated briefly as follows—

Neglect of or careless picking of rollers and underclearers. Careless brushing down; the brush requires constant cleaning to remove lumps: beating or fanning them away should be prohibited. Stop machines when brushing down. Bad piecings of bobbins. Roller laps. Allowing bits of roving to fall when creeling, especially the front row of bobbins. Dirty and bad top rollers. Dirty sliver guides. Overlapping of slivers in piecing up. Dirty tables. Dirty cylinder ends. Damaged needles and combs. Cans over-running. Neglect of wiping down creels, bobbins and plates and picking of creel pegs. Piecing up with dirty or oily fingers.

Mules. Many of the notes regarding card room machinery are applicable to the mules, especially those regarding picking of rollers and clearers, brushing down and general cleanliness of creels, bobbins, skewers, etc. Scavengers will assist, but they are never adequate. Piecing up of rovings should be done properly, lightly twisted, and no more than one inch overlap. Do not waste material by allowing bobbins to be broken out too soon. Break out a bobbin with sufficient length to allow piecing before the end runs through and break off an inch or two of the new bobbin before piecing up. Use up the pieces that are broken out as early as possible, and see that they do not gather fluff. Run a full bobbin with a half bobbin.

See that the return band weight is free to fall, and that it never touches the floor, and renew the band before it shows serious wear. It is a serious fault to allow any band to break before

renewing it; the loss in other directions is then far greater than any saving in cost of the bands. Spindle tops, warves and bolters should be kept clean. No dirt or spindle band ends should be allowed to lodge on the spindle footsteps.

Tie spindle bands with a sailor knot, not a "granny" knot.

Mark the amount of incline on the back shaft scrolls so that the amount used can be seen after altering the knocking out. Adjust the drawing-up scrolls so that the carriage reaches the back stops gently. Adjust the friction cones as they wear or become compressed. See that the carriage is perfectly parallel to the rollers. Judgment of tension in a band is the main point. If bands are not in equal tension, due to stretching, they must be tightened, the particular band to be tightened depending upon the direction in which the carriage is out of line. Always start squaring from the outend. The squaring bands under the carriage should be in equal tension. Do not stop a spindle after piecing up. See that no adjacent cop has wound on an end that has broken when the carriage is running in.

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PREFACE

In this volume, the student and the practical man are first made acquainted with the characteristics of the raw material and its various sources of supply. Hitherto, the usual course of instruction from this point has been to describe each process and the machinery through which the cotton passes until it is made into yarn. In doing this, it has been customary to describe all the numerous mechanical details and to point out the operations of mixing, doubling, drafting, opening, cleaning, combing, parallelizing, etc., as they occur in each machine. A constant repetition naturally occurs in this system of instruction.

The better method has been adopted in the present book of treating each of the processes or elements as separate items and giving the various mechanical methods of carrying out the desired effects. All this is done before any complete machine is described. The reader has thus presented to him a clear idea not only of what is necessary to transform the cotton fibres into a certain state, but also the various mechanical elements suitable for carrying out the operation. With a fundamental knowledge of this kind it becomes a simple matter to grasp quickly how a complete machine is built up from the component mechanisms. Also, the reader is able to form a judgment as to the mechanism best suited to any given process. The complete machines are described and illustrated for guidance, and the whole

of the processes in the mill up to the spinning of yarn is made clear.

The size of the book has naturally led to a severe condensation of this new method of acquiring and deepening a knowledge of cotton spinning, but the author and publishers hope that the volume will prove both interesting and valuable not only to the student, but also to those practical men who are apt to look on each process in a mill as a separate entity disconnected from every other process.

Teachers and students will find that the volume is applicable to the suggestions made by the Board of Education in its Memorandum on the Teaching of Textiles.

The author's 3 volume book on "Cotton Spinning" may be consulted for very full details of machinery and processes, and his book "Cotton Spinning Calculations" gives all necessary rules and gearing plans of mill machinery. Other reference books are mentioned at the end of this volume.

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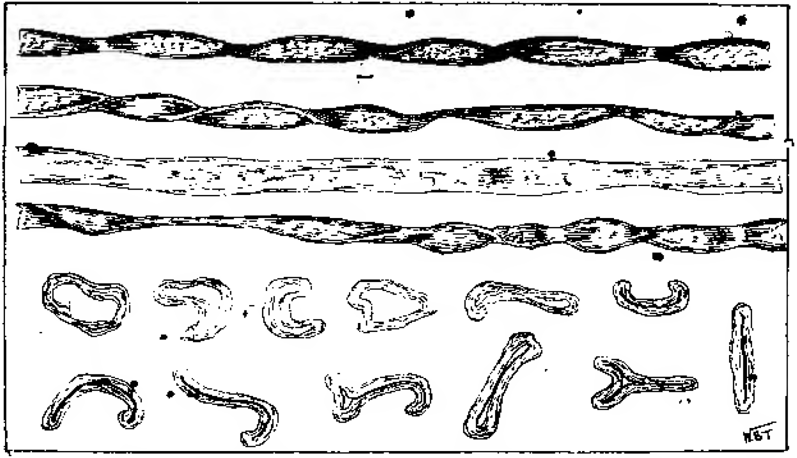

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AND ITS USES

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FOR TEXTILE ENGINEERS, MILL WORKERS, AND STUDENTS

BY

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MEMBER OF THE INSTITUTION OF MECHANICAL ENGIN'S
MEMBER OF THE TEXTILE INSTITUTE
AUTHOR OF "COTTON SPINNING," ETC.

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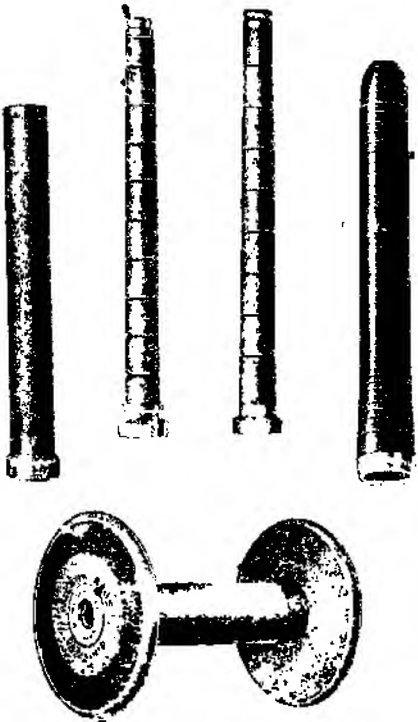

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